

CO from the Russian Fires-2010 observed by AIRS, MOPITT, and ground-based instruments

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Outline

AIRS and MOPITT track CO from forest fires perfectly. However, both **underestimate** CO from forest fires in the boundary layer.

How large is the error for CO total column?

Here we present measurements of 4 ground-based instruments that measured CO synchronously with satellites.

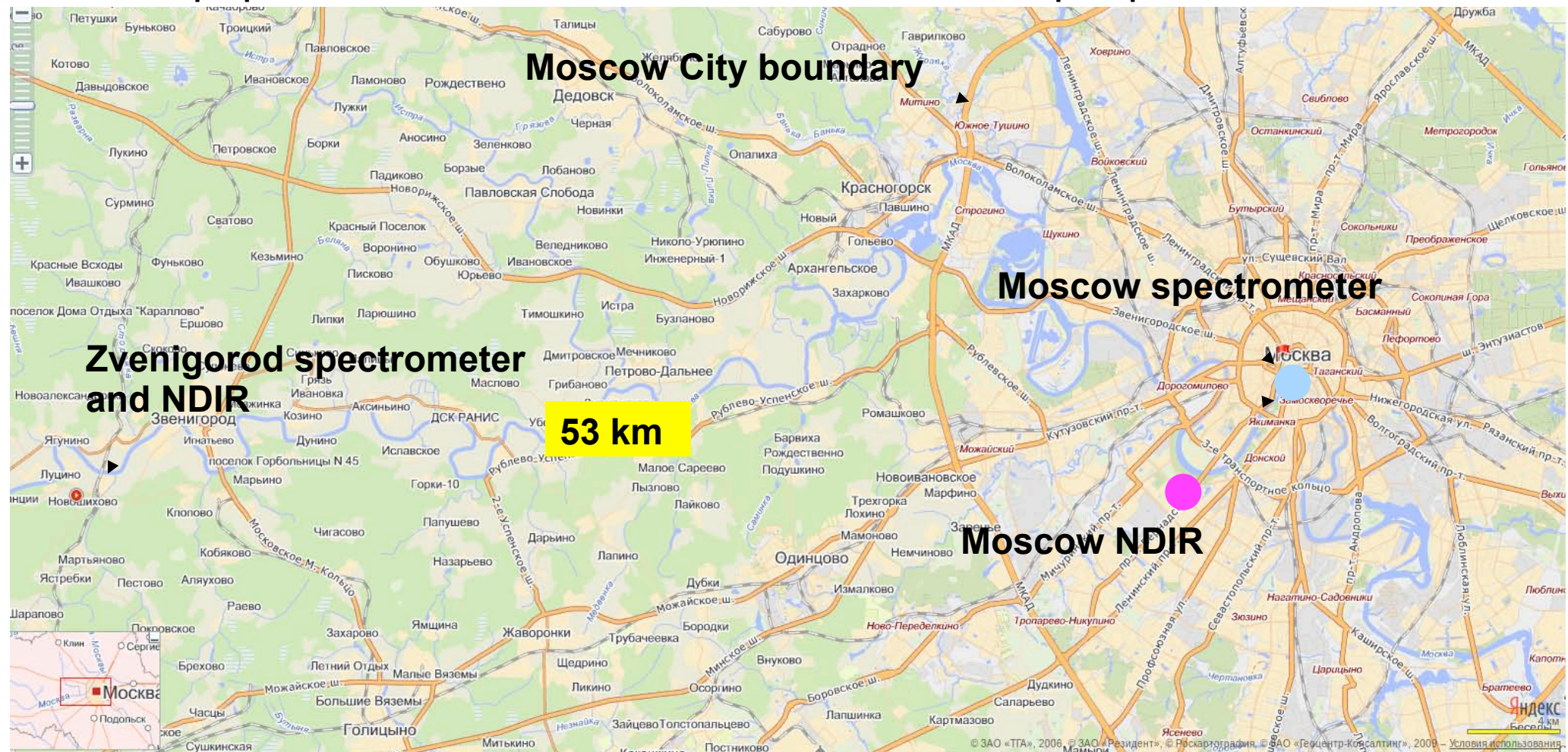
Corrections in AIRS and MOPITT data are expected to change estimates of CO emission dramatically. .

Ground-based facilities:

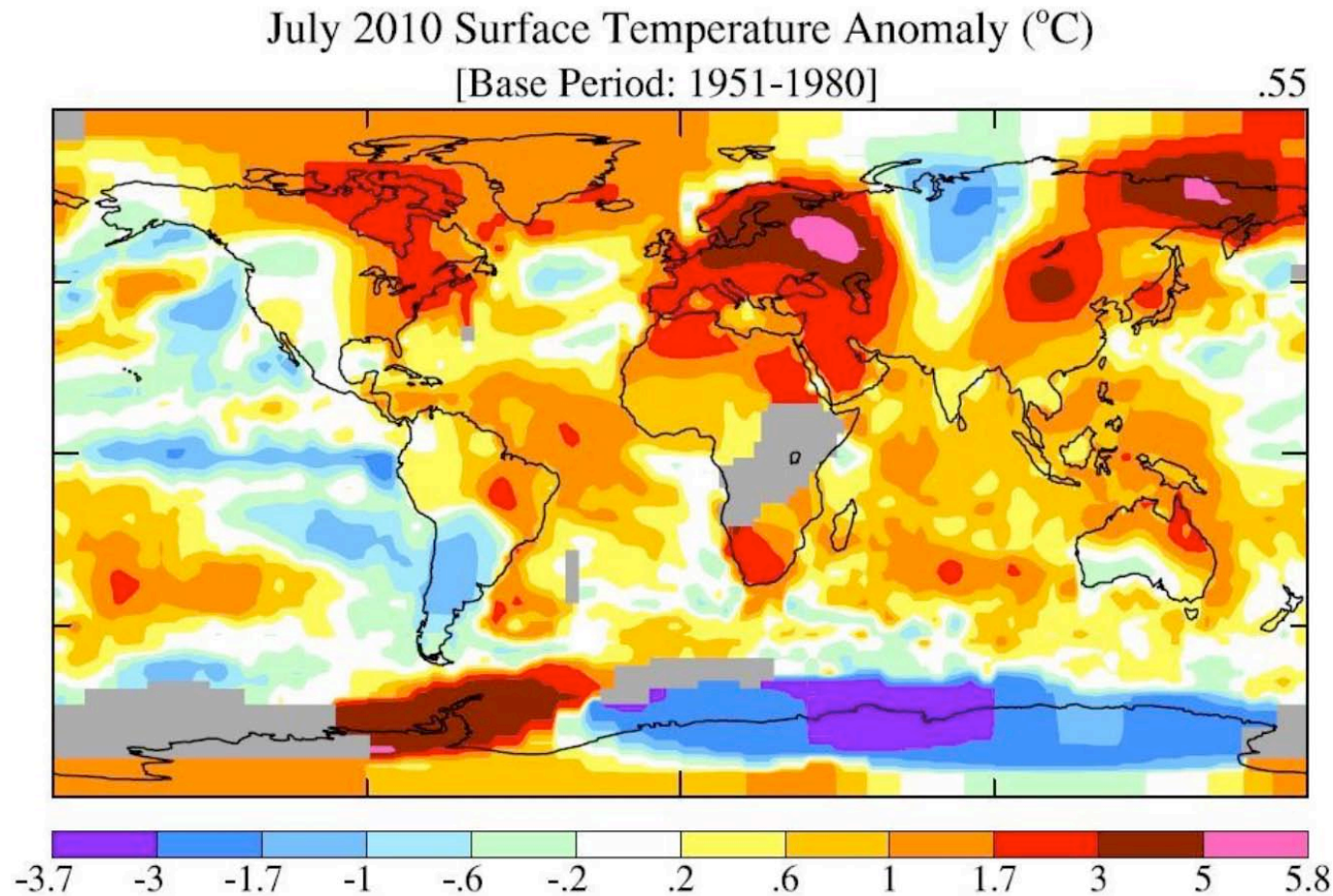
Two **grating solar-tracking spectrometers** of 0.2 cm⁻¹ resolution Retrieval by scaling a priori profile to minimal residual

Two **Non-Dispersive IR (NDIR) analyzers** Thermo Electron 48i-TLE

Moscow population is between 11 and 14 millions of people.



July-August of 2010 was abnormally hot in Central Russia.
Mean August temperature, +21.8 C, was 5.4C higher than normal. During 22 days daily means were record high. The new absolute maximum has been reached in Moscow, +38.2C.
[Hydrometeocenter of Russian Federation].



[<http://data.giss.nasa.gov/gistemp/2010july/>]

The drought caused **forest and peat fires** in Russia. The area of fires, according to official data, amounted to 500,000 ha (1.25 E6 acre) in the beginning of August. **Smoke** spread over vast areas, including Moscow.

Due to the heat and smoke the additional number of deaths in Central Russia amounted to **14,130** cases in July only, that can be compared to the effect of the heat wave in France in 2003 (14,400 deaths). In **Moscow** in July the number of deaths were **4,824** more than in 2009; in August this number was **6,111** more than during the previous year. [*Bull. Izmenenie klimata N18 09 Sept 2010*].



Smoke in Moscow

Smoke in Moscow





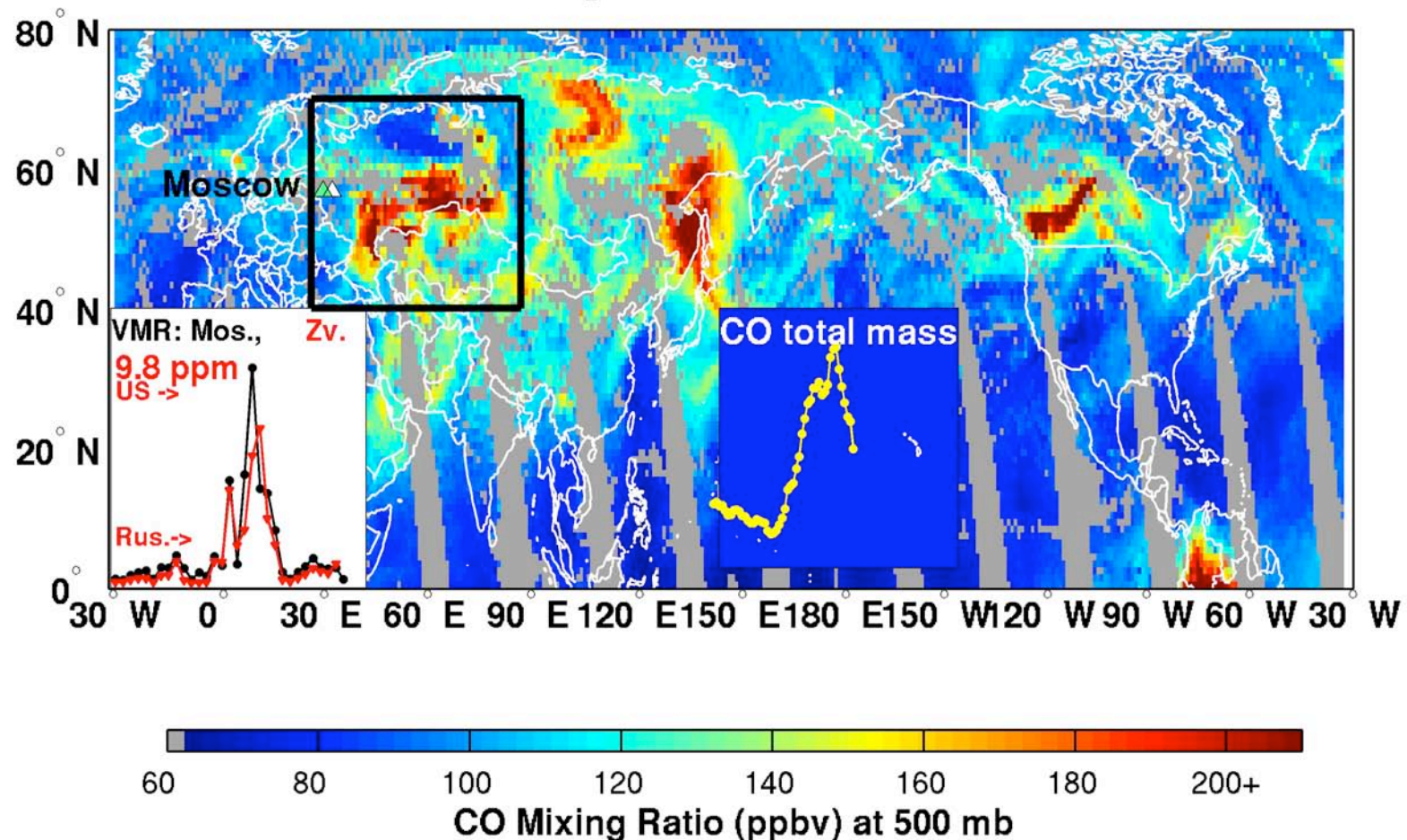
City of Voronezh



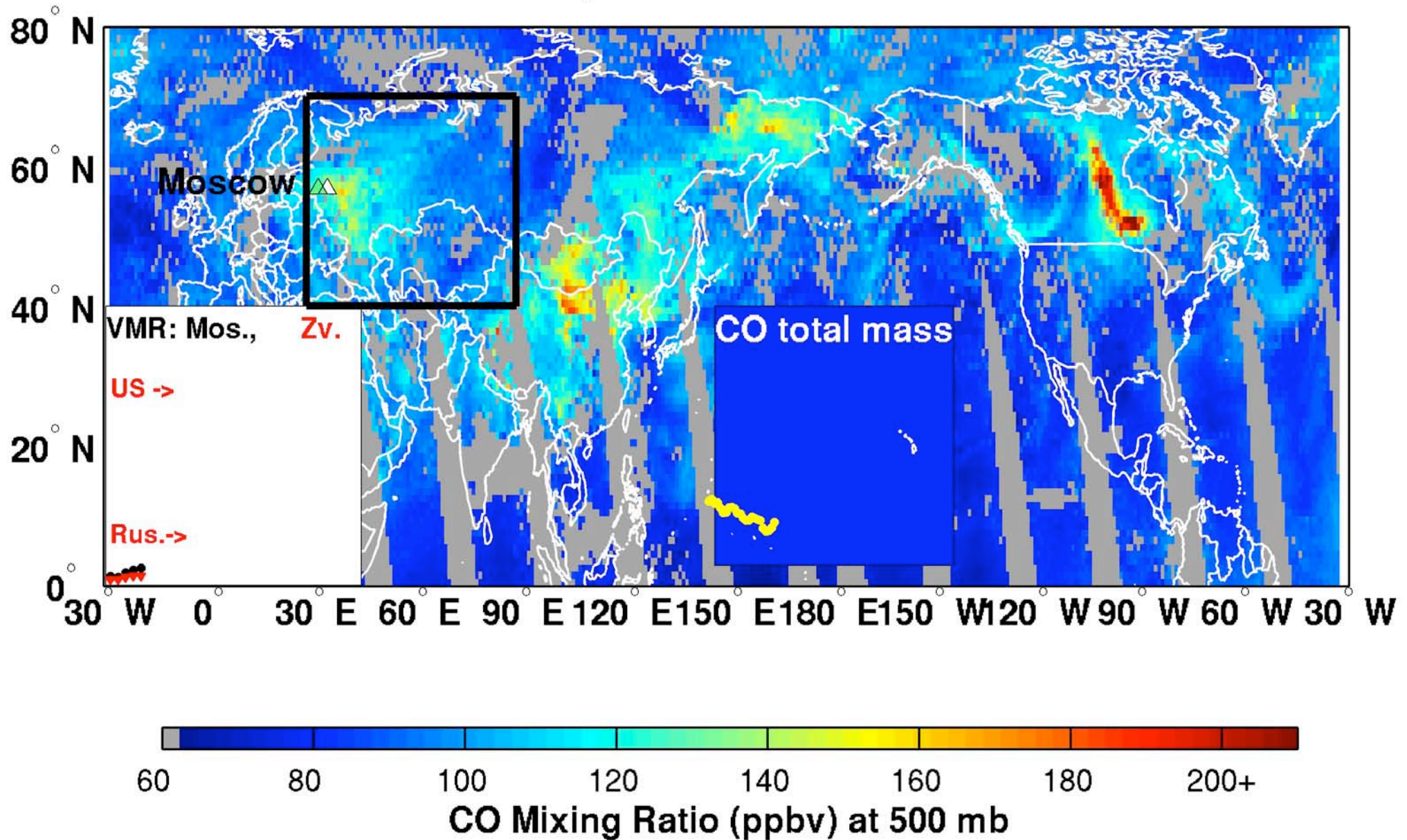
Burnt village

AIRS V5, L3, CO movie

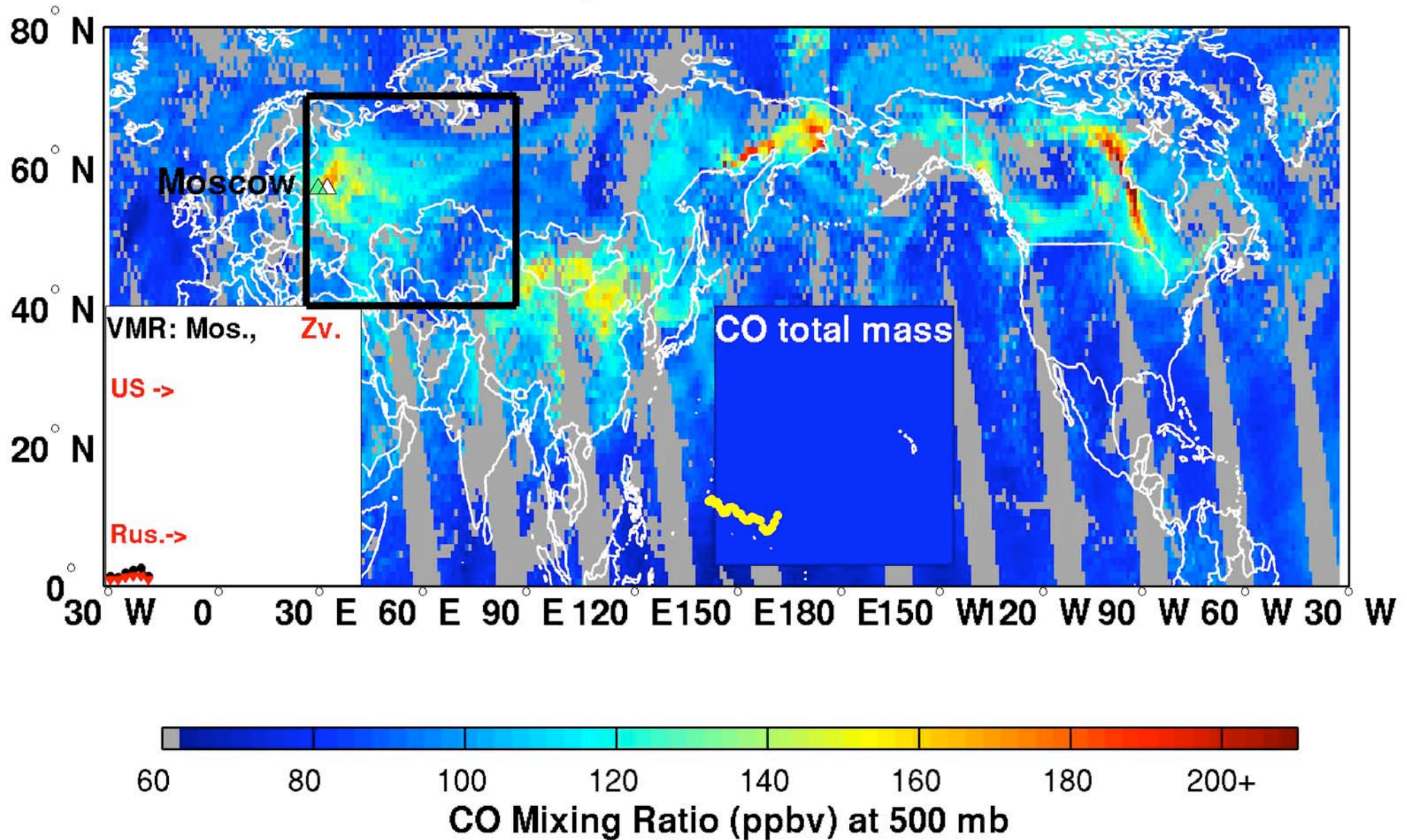
Local noon (ascending) AIRS CO at 500 mb on 2010.08.19.



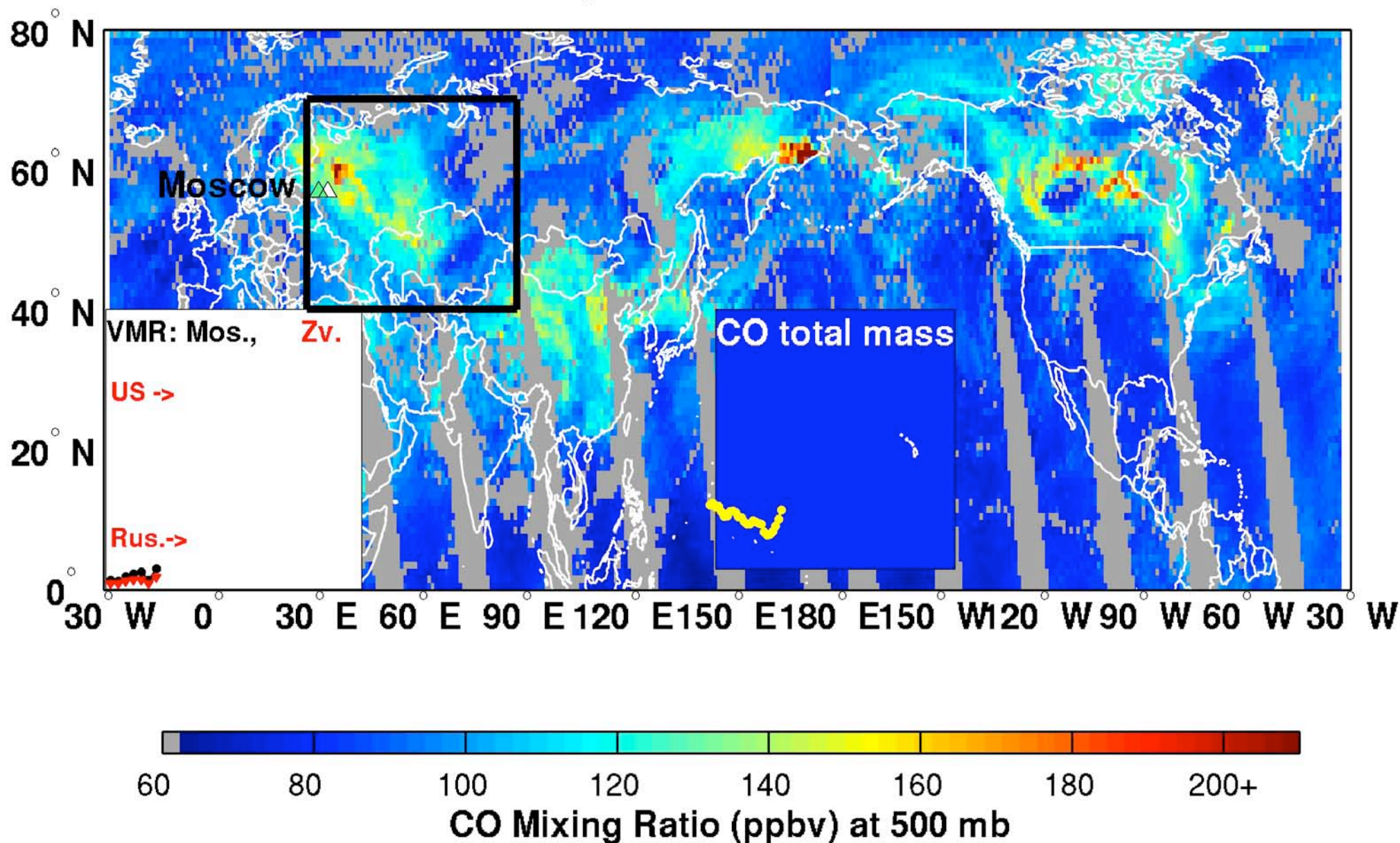
Local noon (ascending) AIRS CO at 500 mb on 2010.07.24.



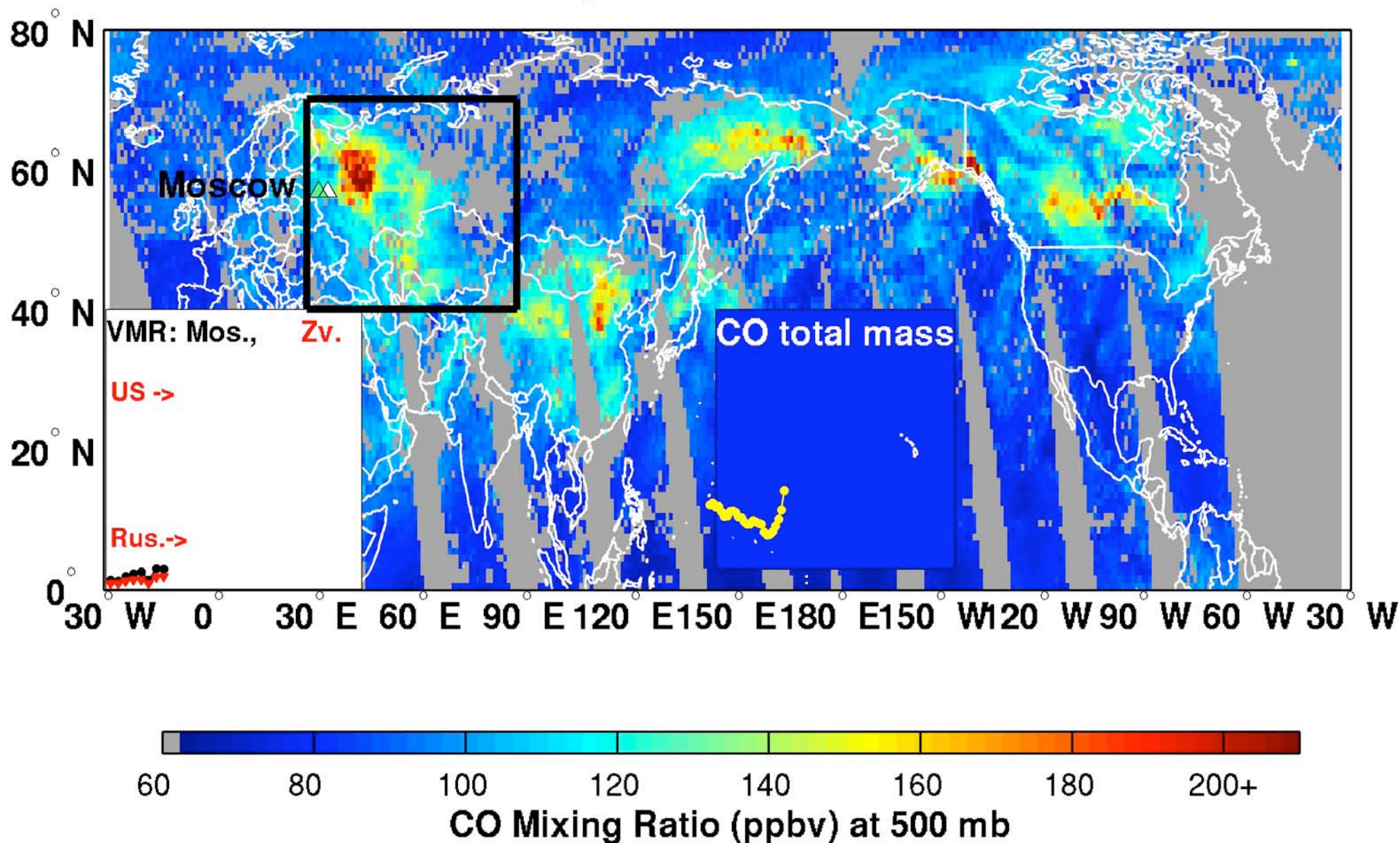
Local noon (ascending) AIRS CO at 500 mb on 2010.07.25.



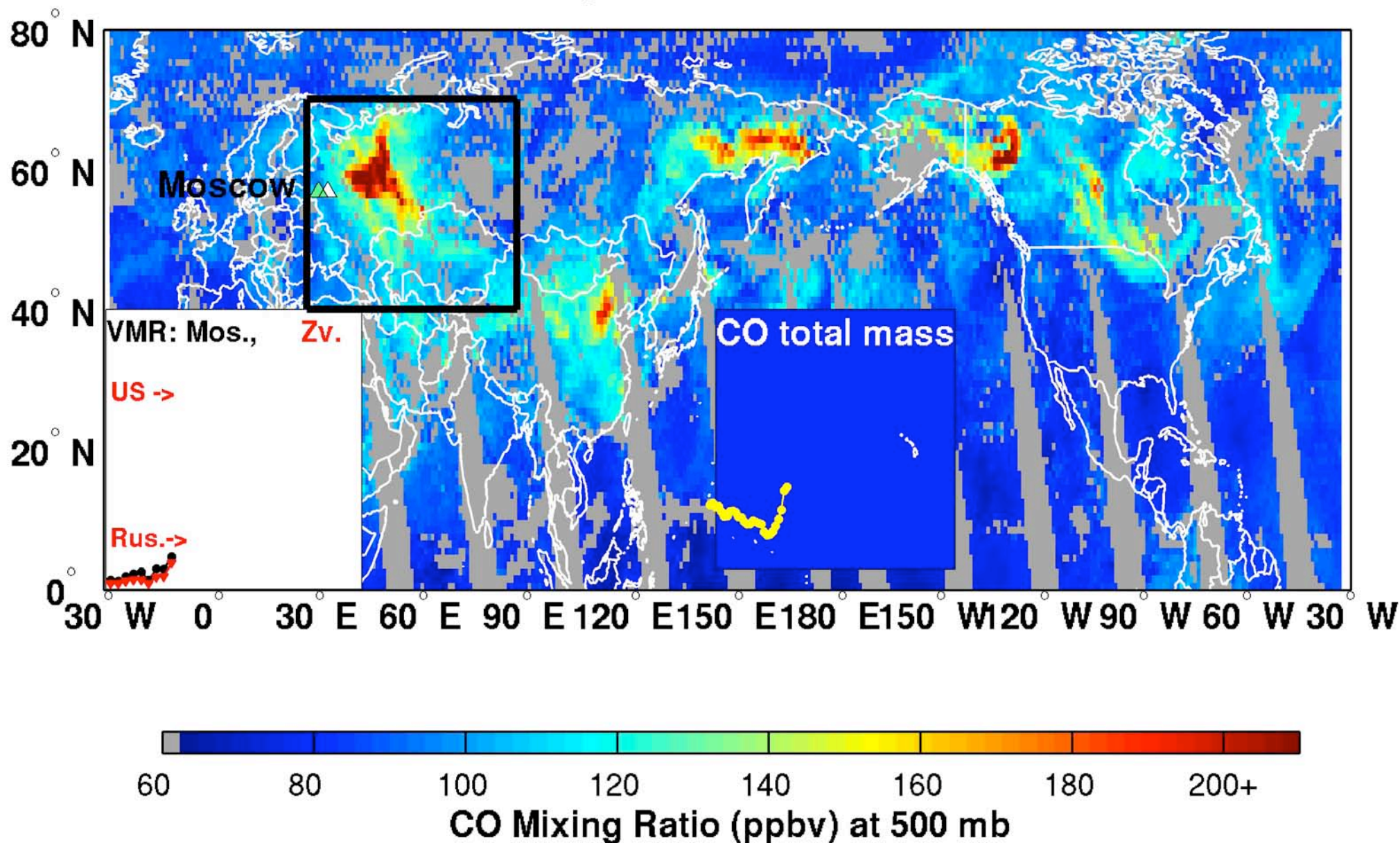
Local noon (ascending) AIRS CO at 500 mb on 2010.07.26.



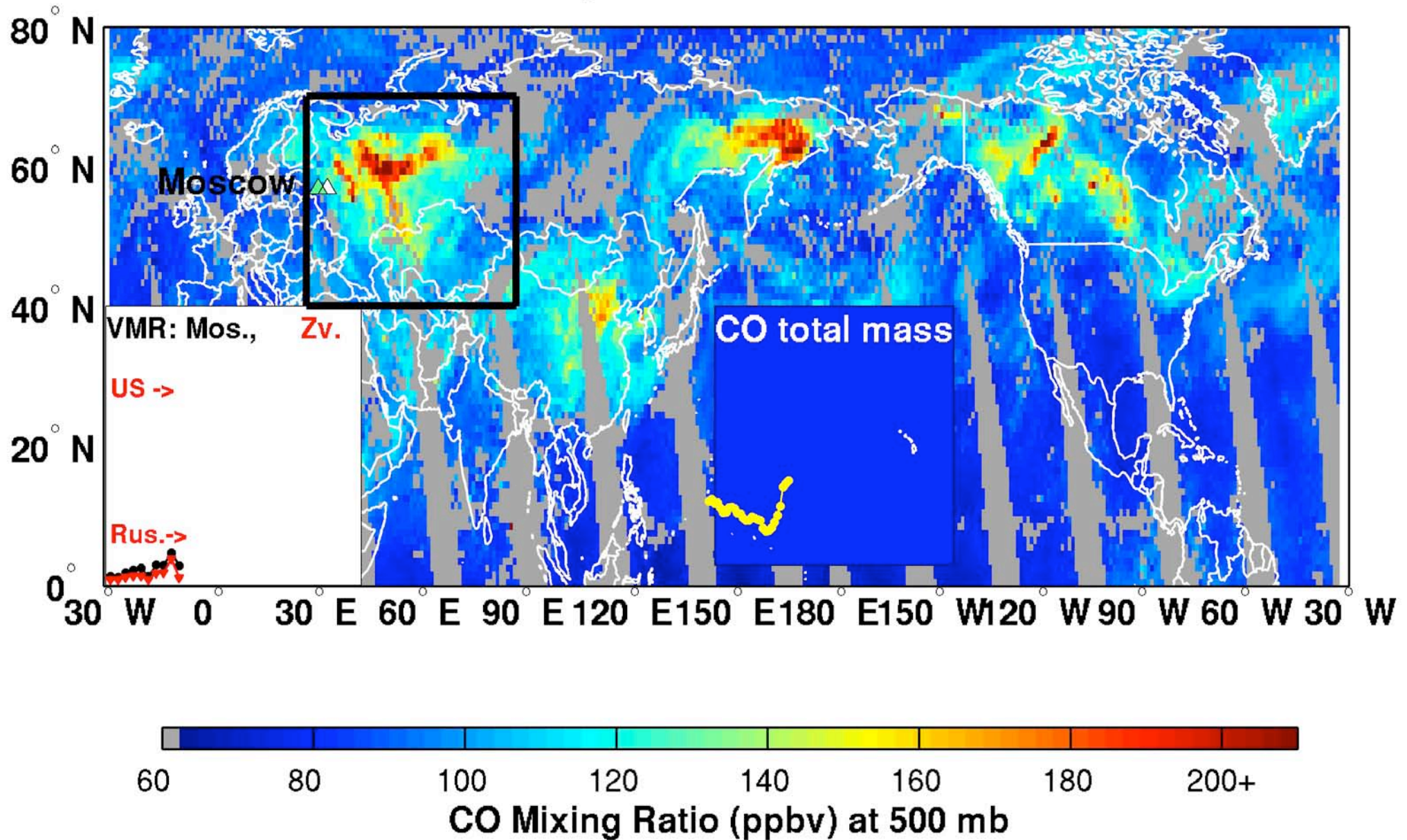
Local noon (ascending) AIRS CO at 500 mb on 2010.07.27.



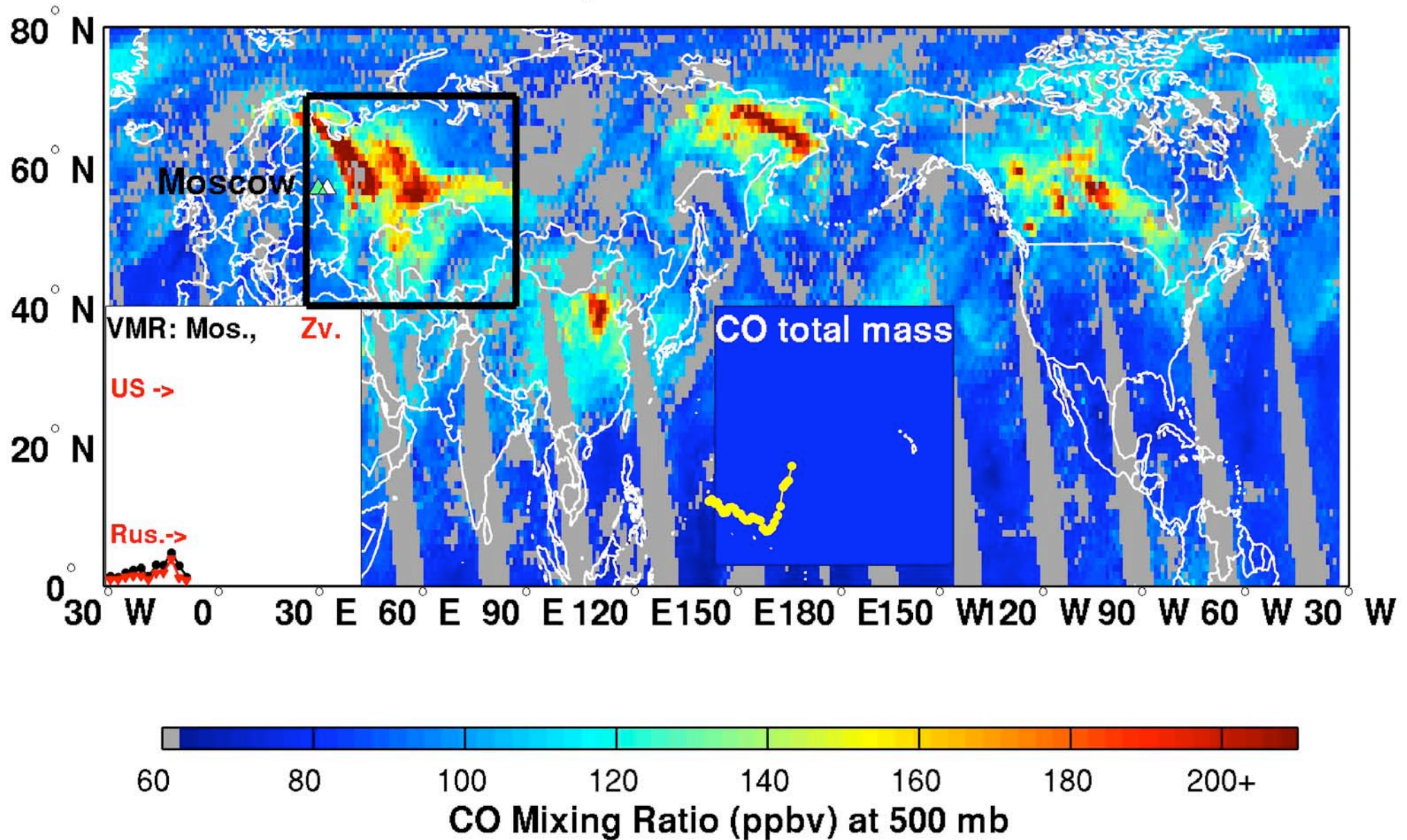
Local noon (ascending) AIRS CO at 500 mb on 2010.07.28.



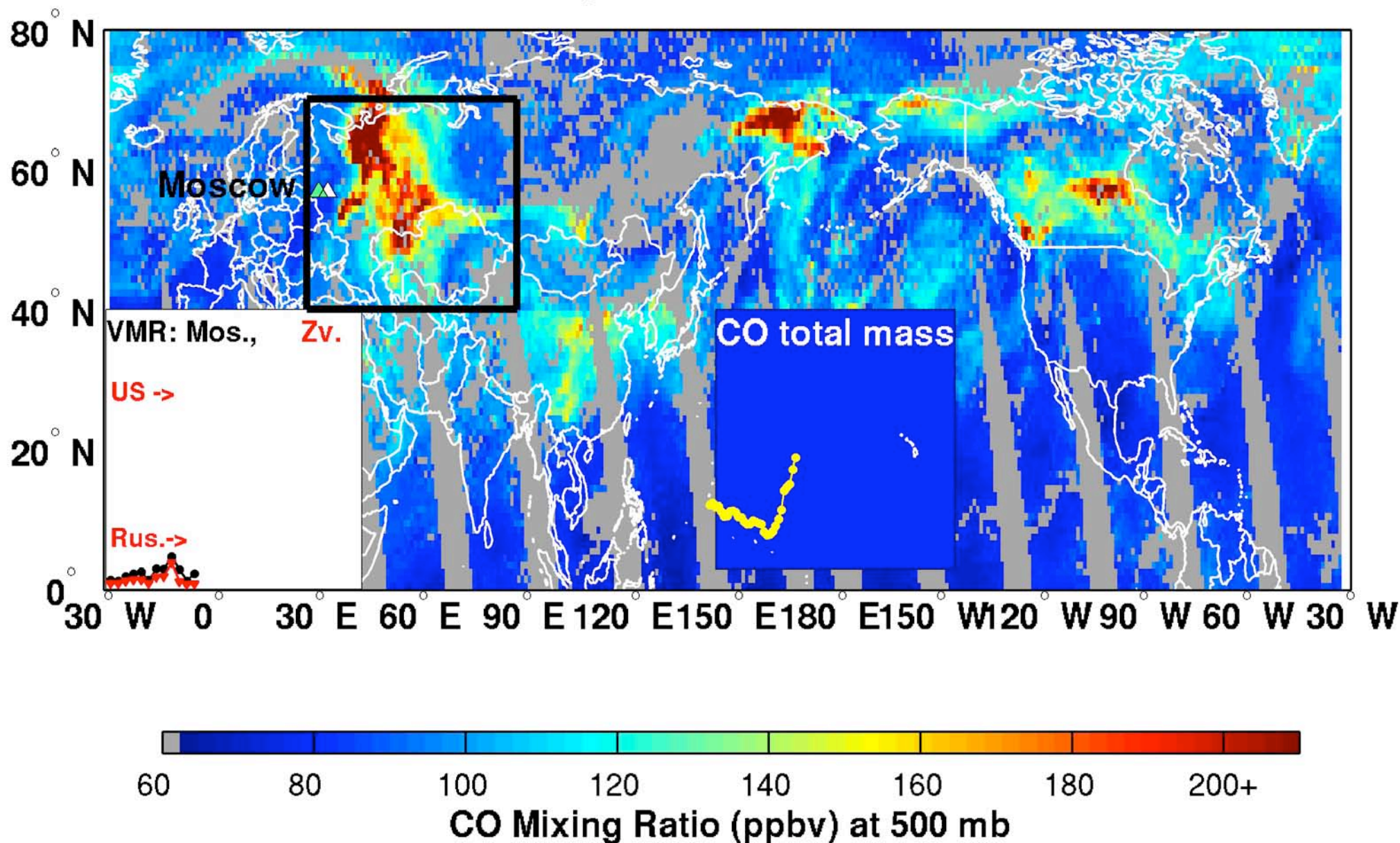
Local noon (ascending) AIRS CO at 500 mb on 2010.07.29.



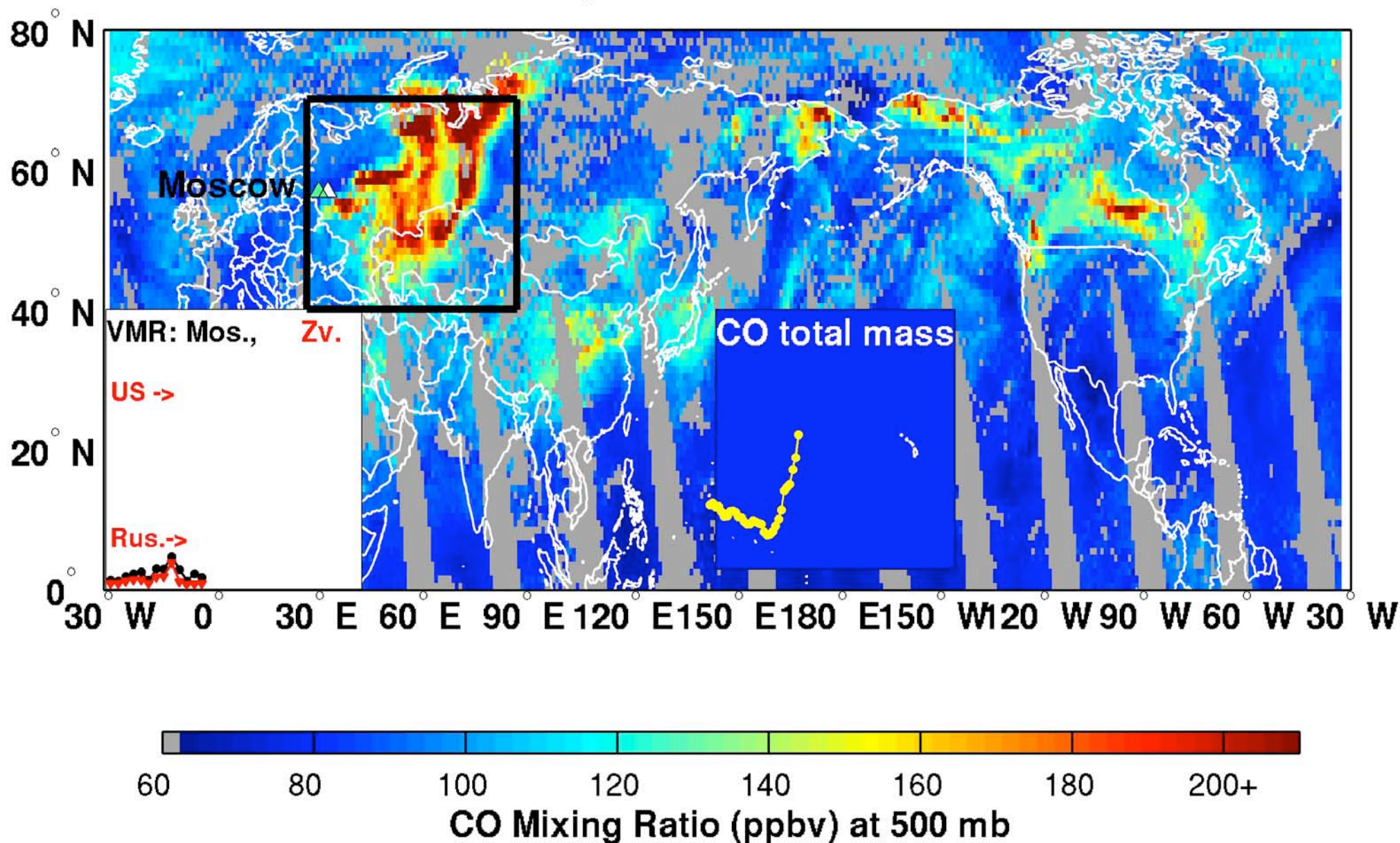
Local noon (ascending) AIRS CO at 500 mb on 2010.07.30.



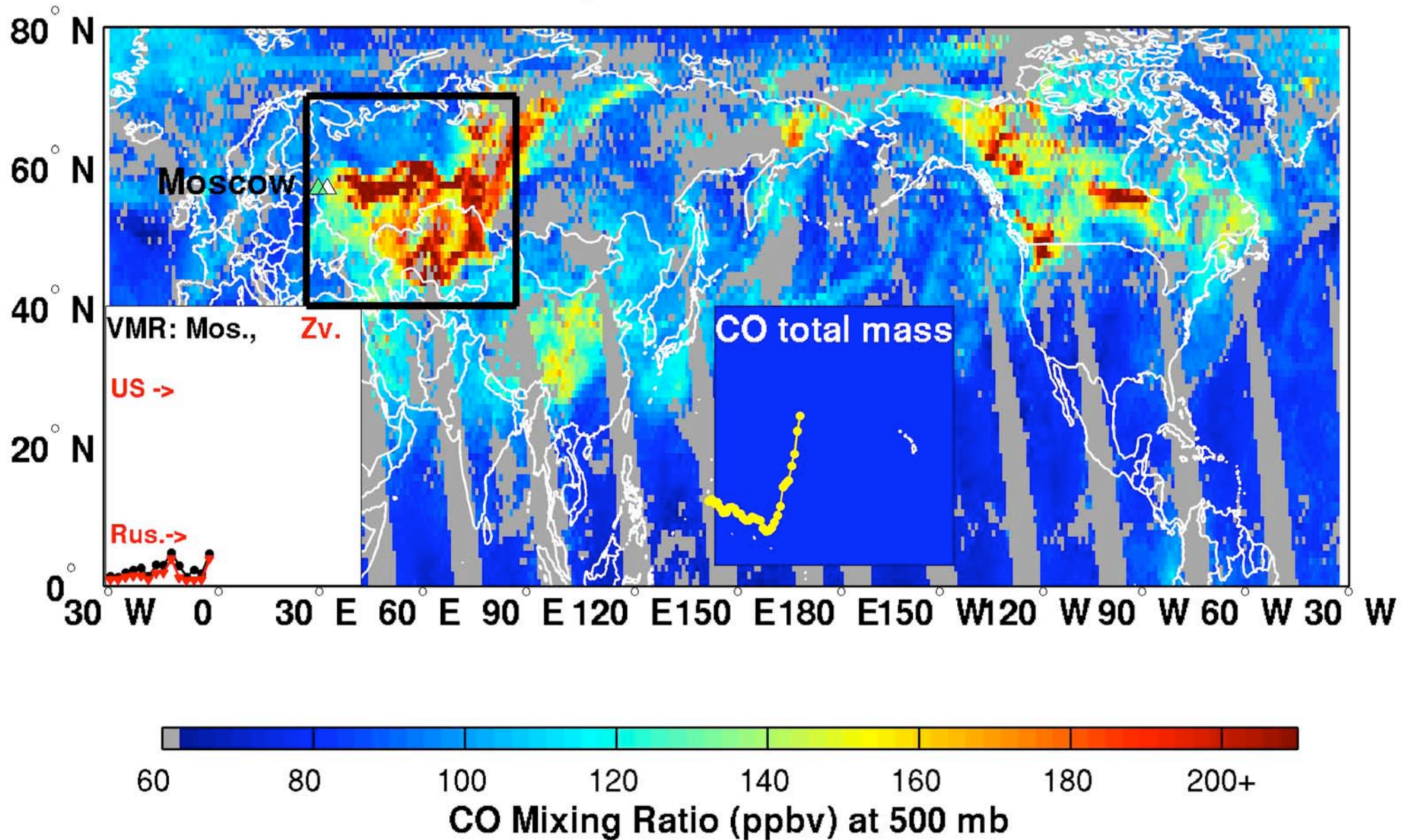
Local noon (ascending) AIRS CO at 500 mb on 2010.07.31.



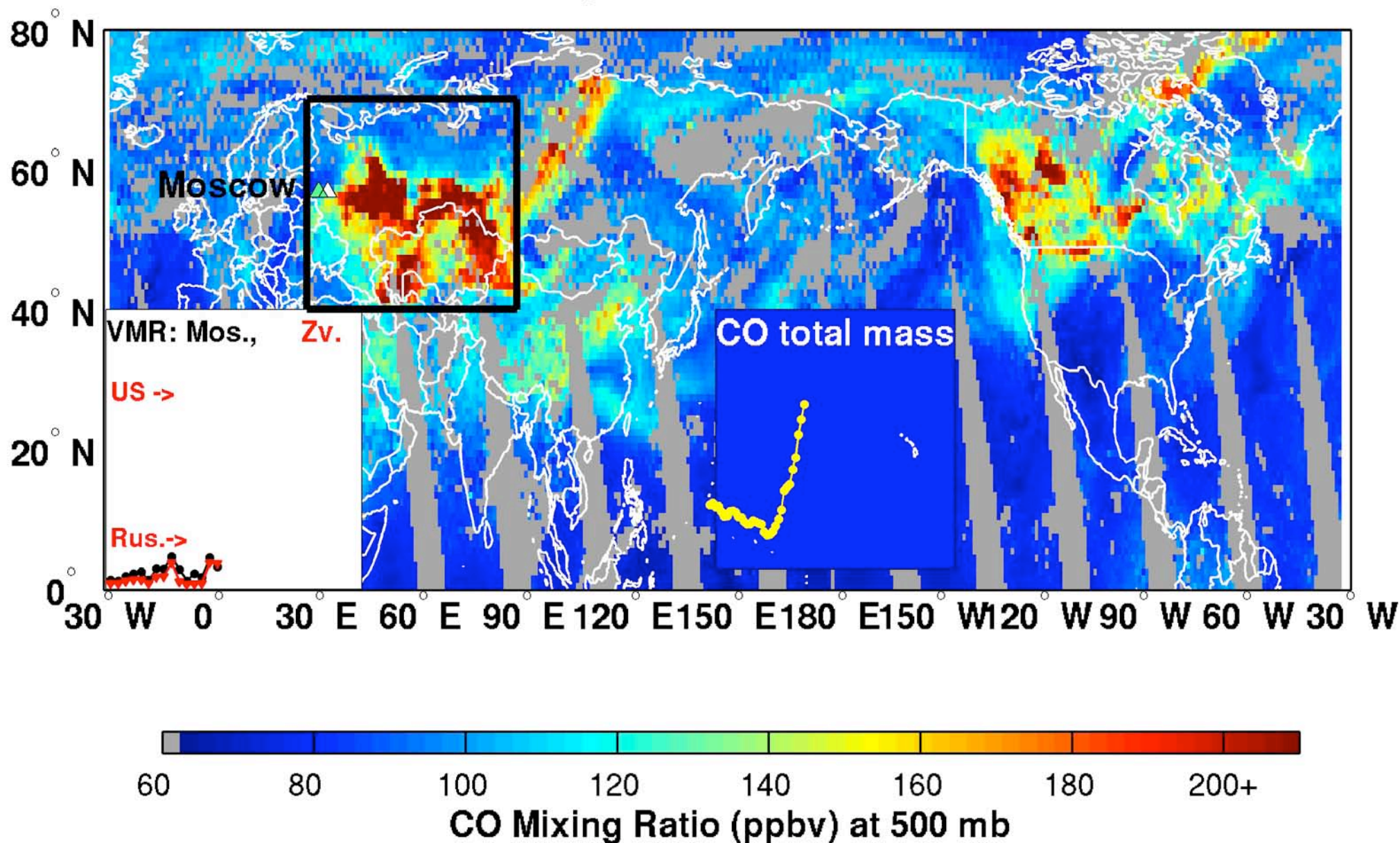
Local noon (ascending) AIRS CO at 500 mb on 2010.08.01.



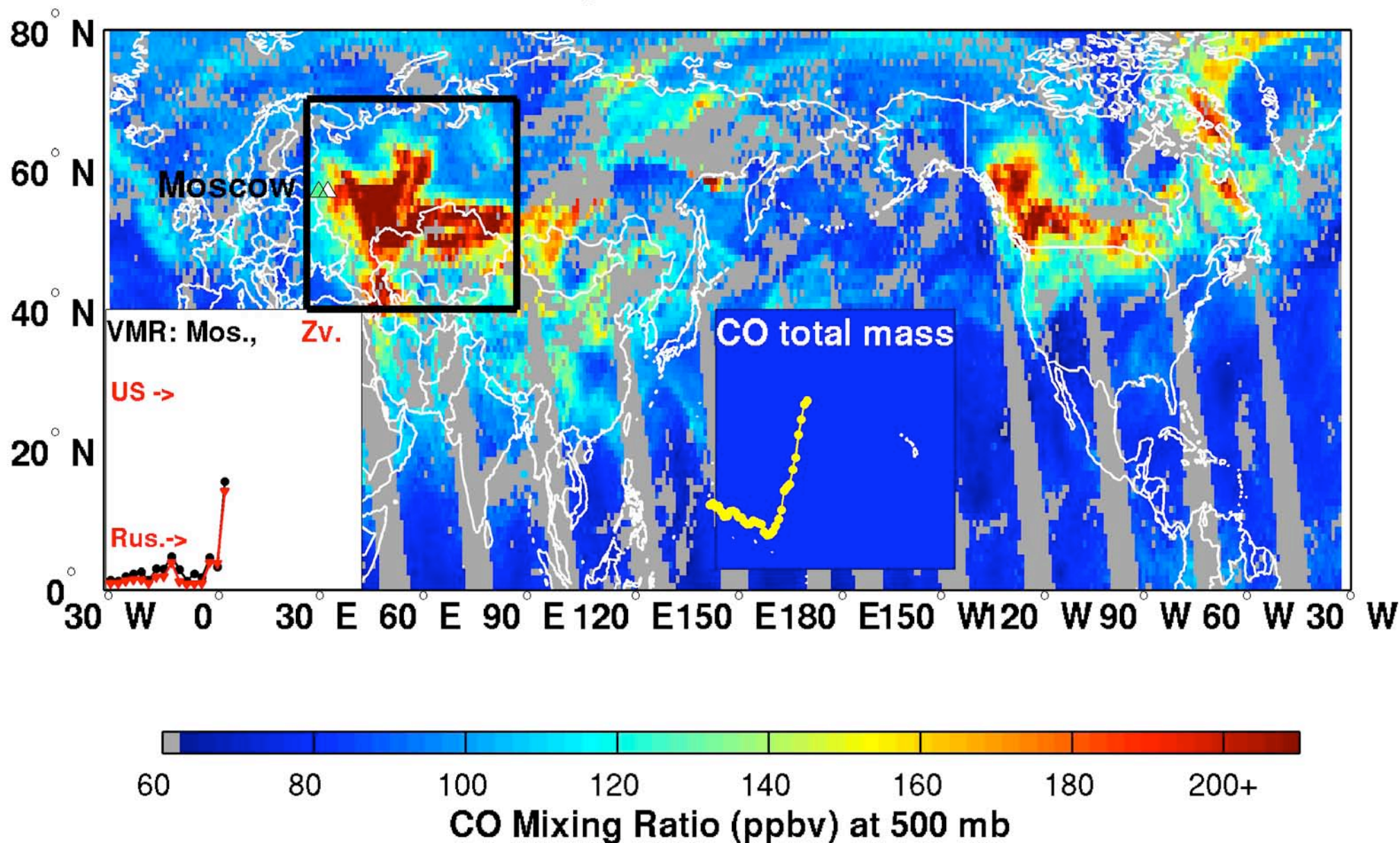
Local noon (ascending) AIRS CO at 500 mb on 2010.08.02.



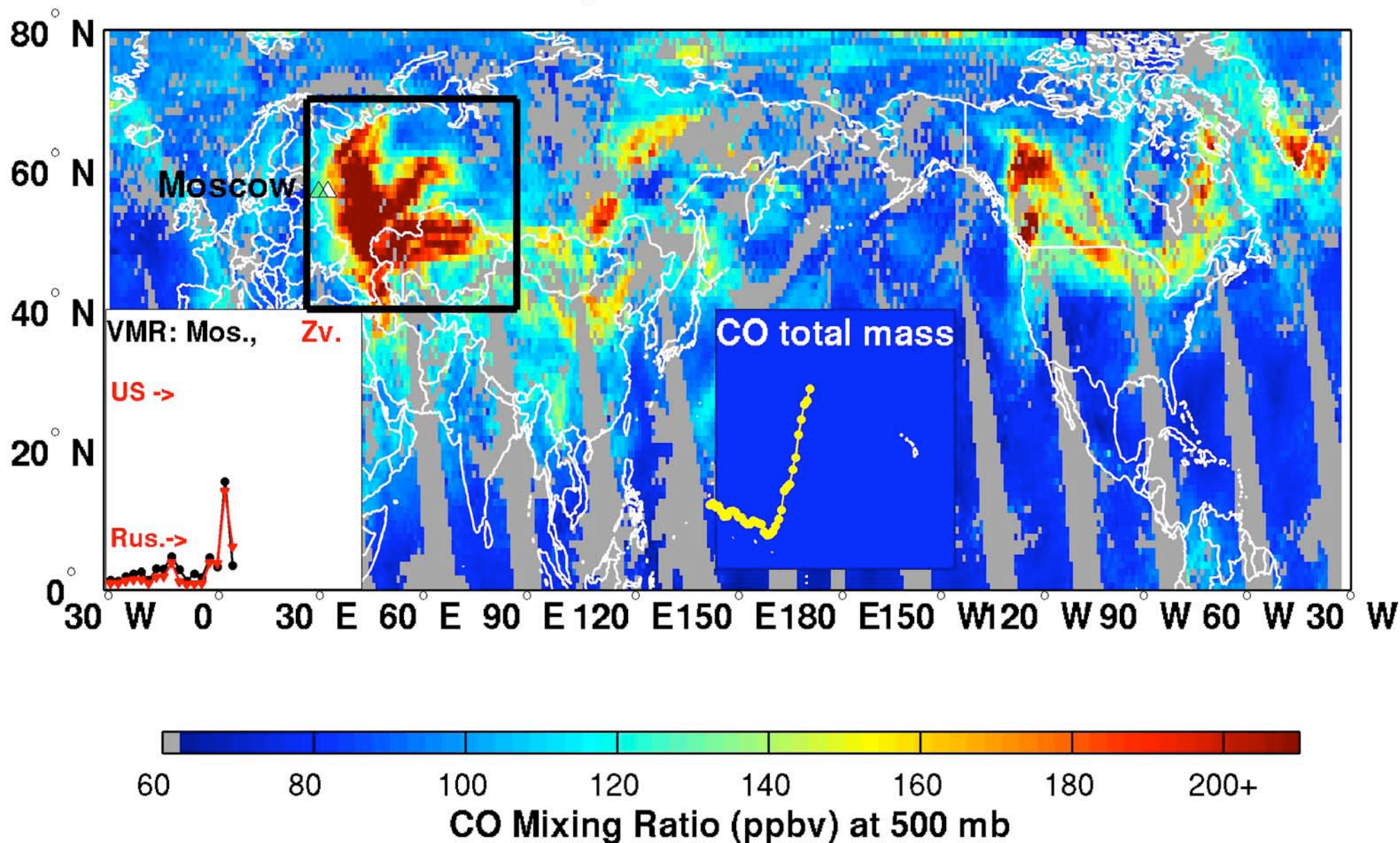
Local noon (ascending) AIRS CO at 500 mb on 2010.08.03.



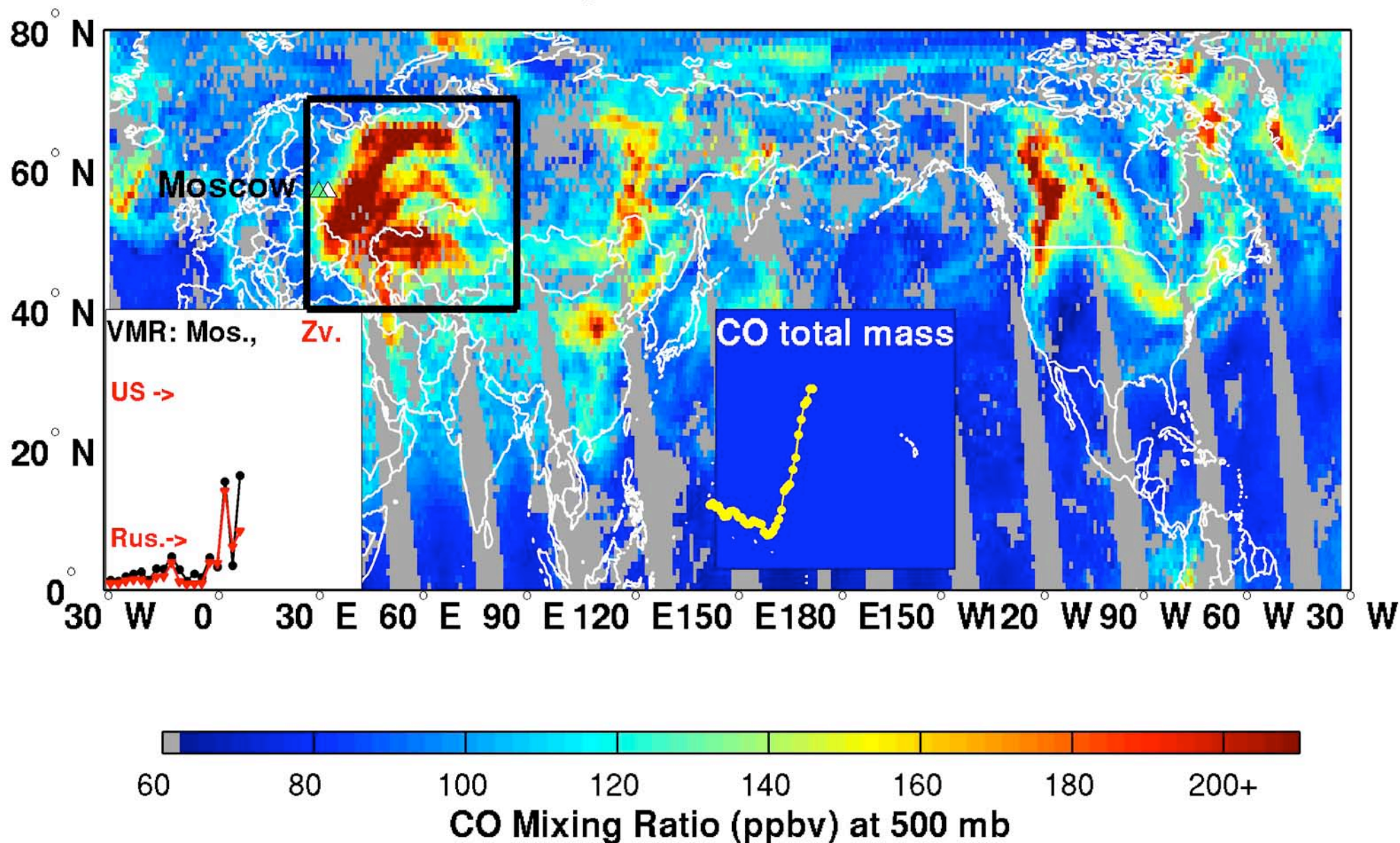
Local noon (ascending) AIRS CO at 500 mb on 2010.08.04.



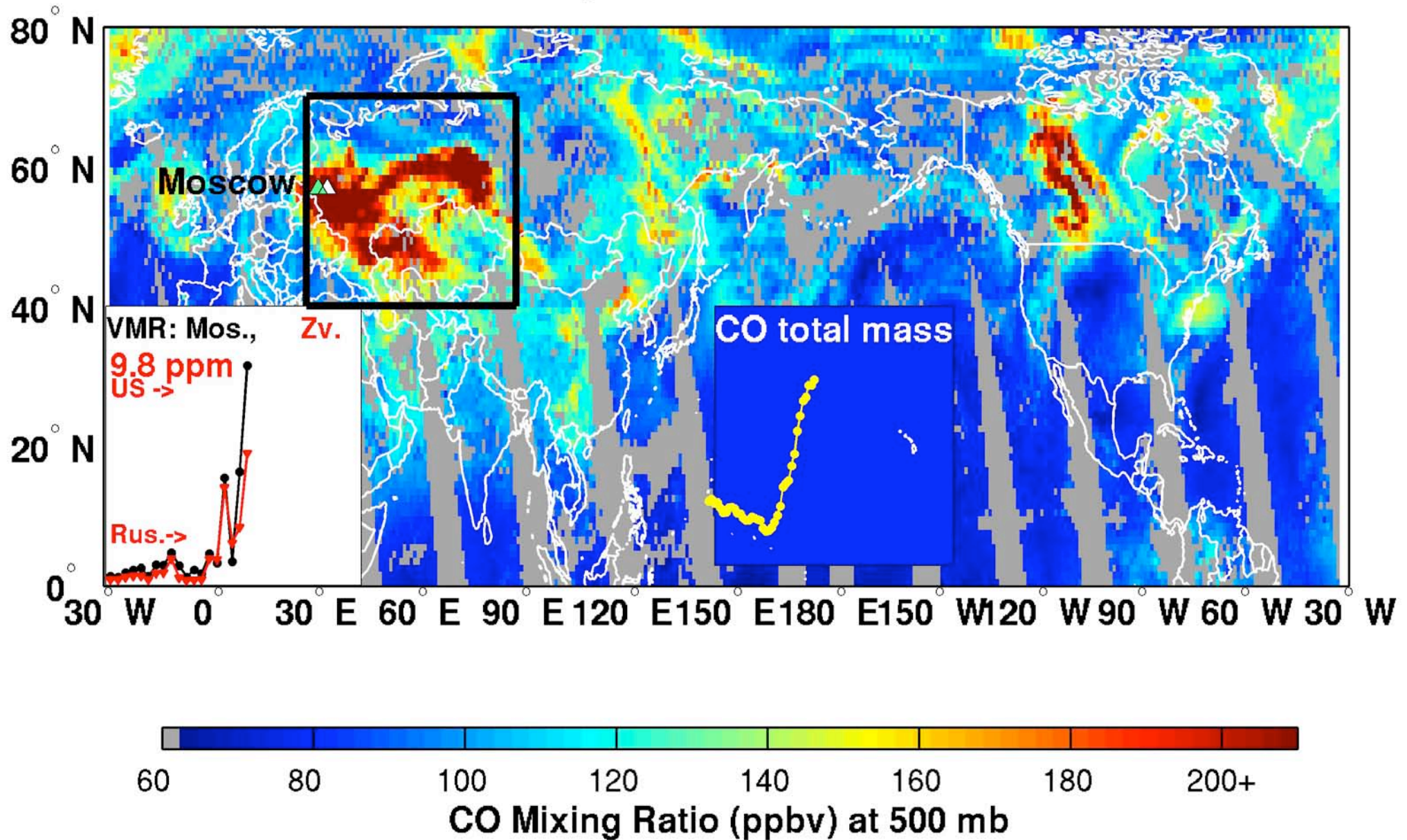
Local noon (ascending) AIRS CO at 500 mb on 2010.08.05.



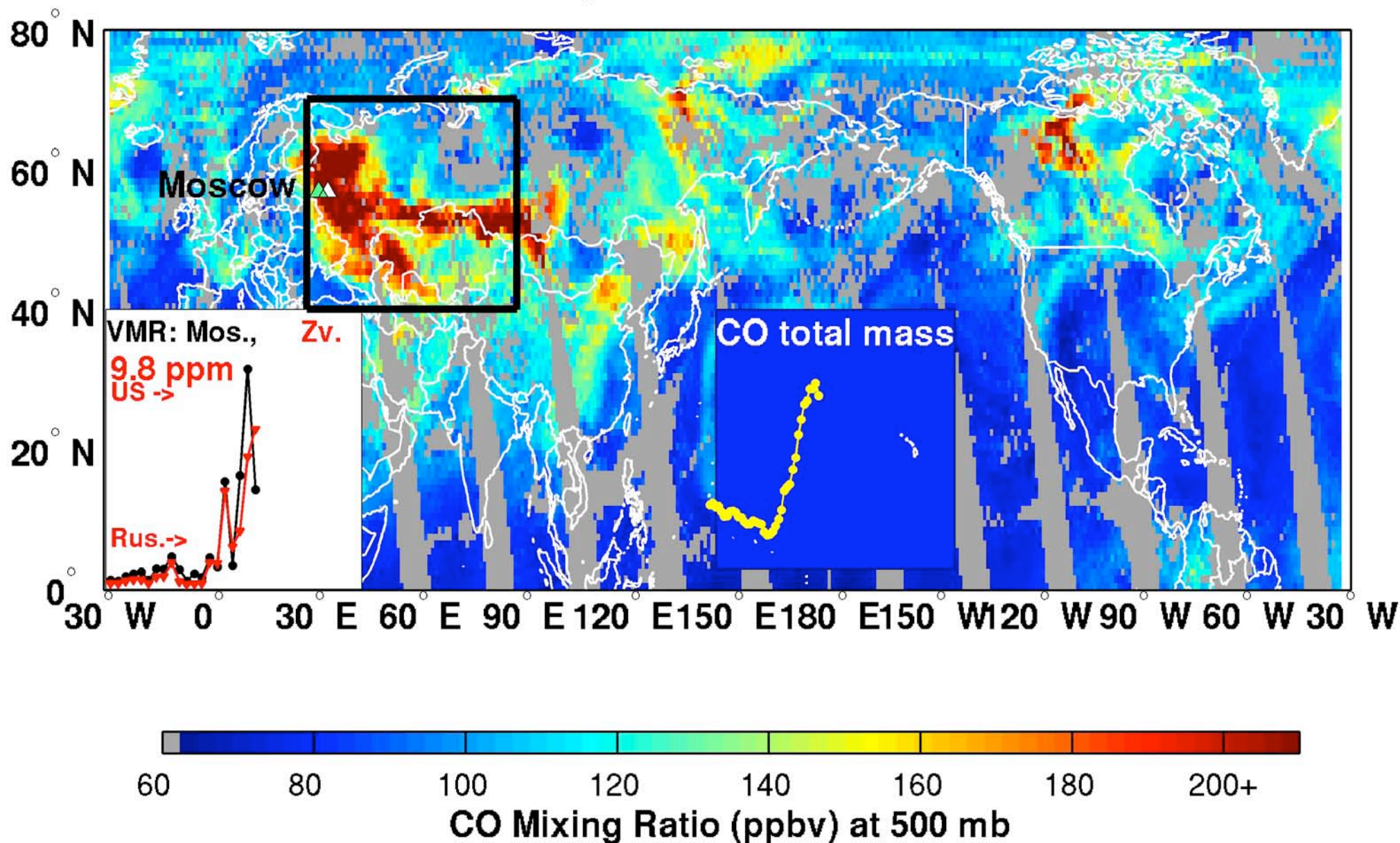
Local noon (ascending) AIRS CO at 500 mb on 2010.08.06.



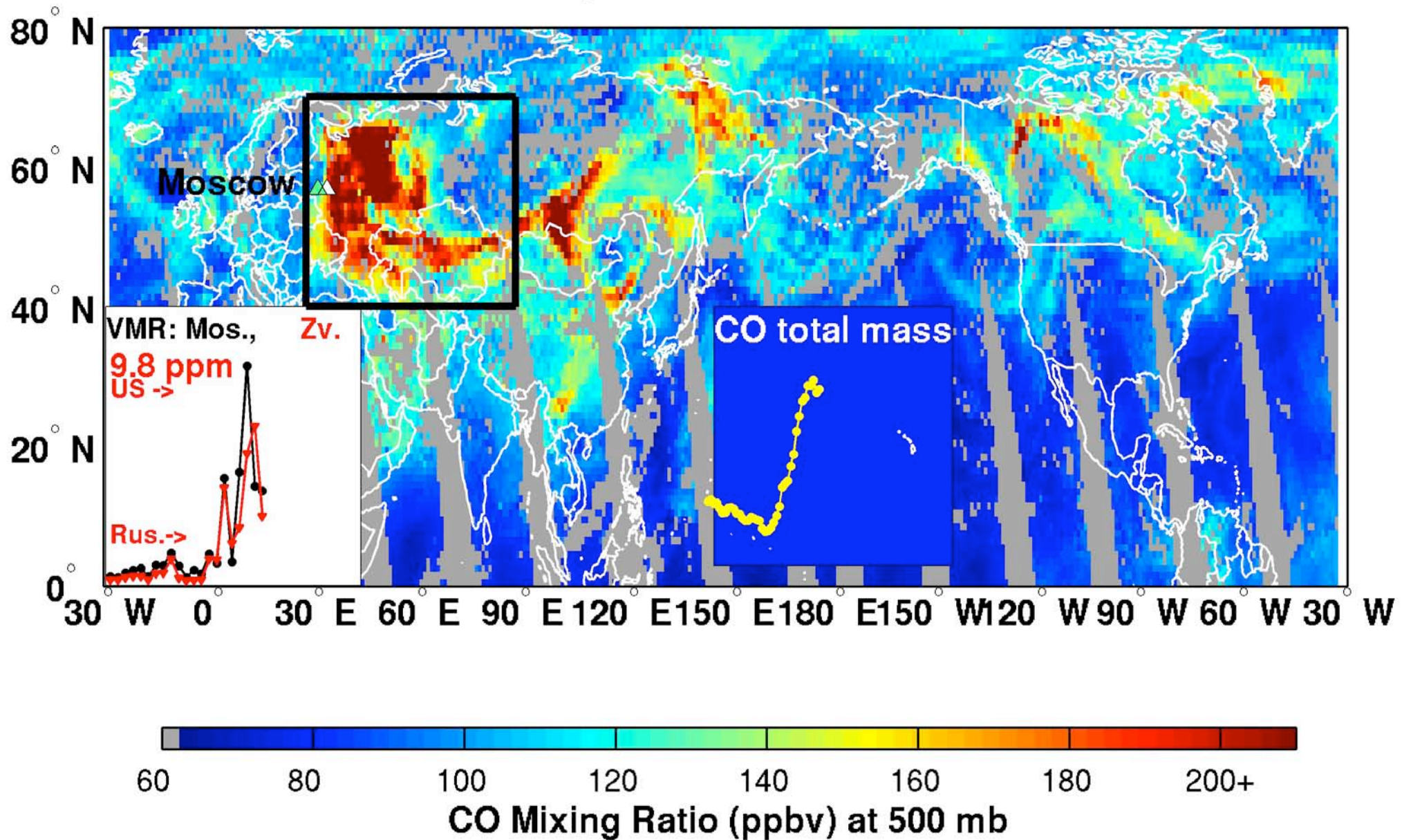
Local noon (ascending) AIRS CO at 500 mb on 2010.08.07.



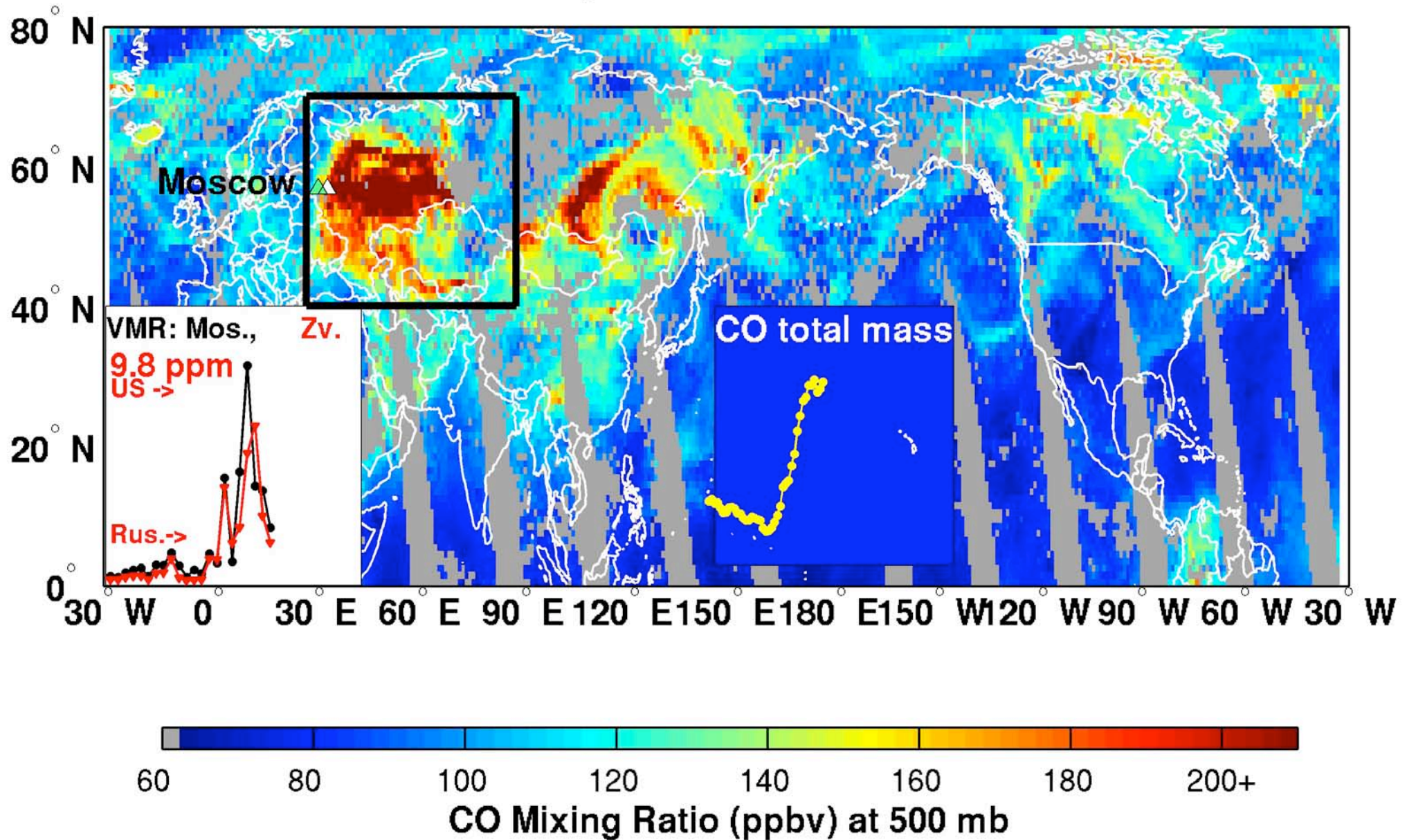
Local noon (ascending) AIRS CO at 500 mb on 2010.08.08.



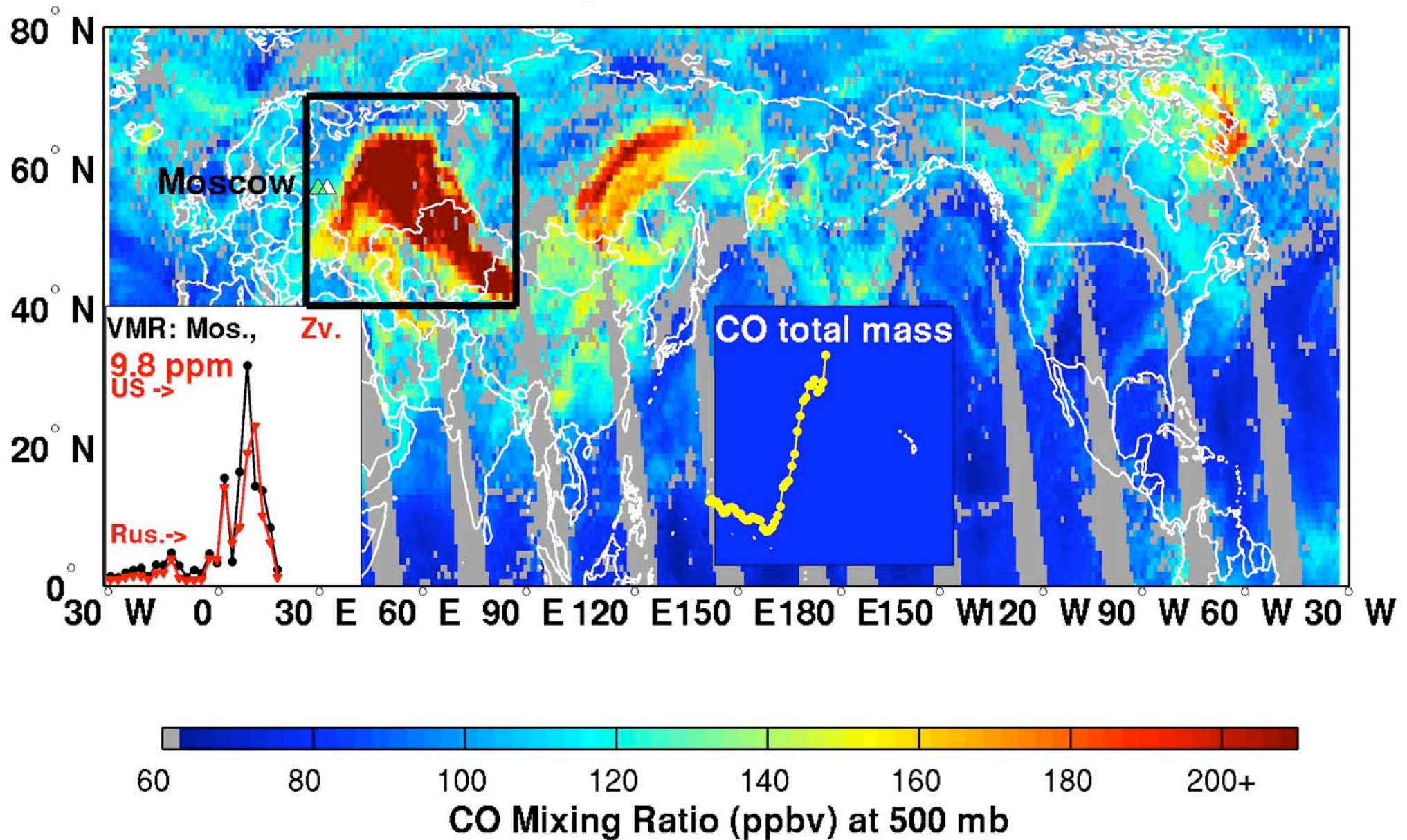
Local noon (ascending) AIRS CO at 500 mb on 2010.08.09.



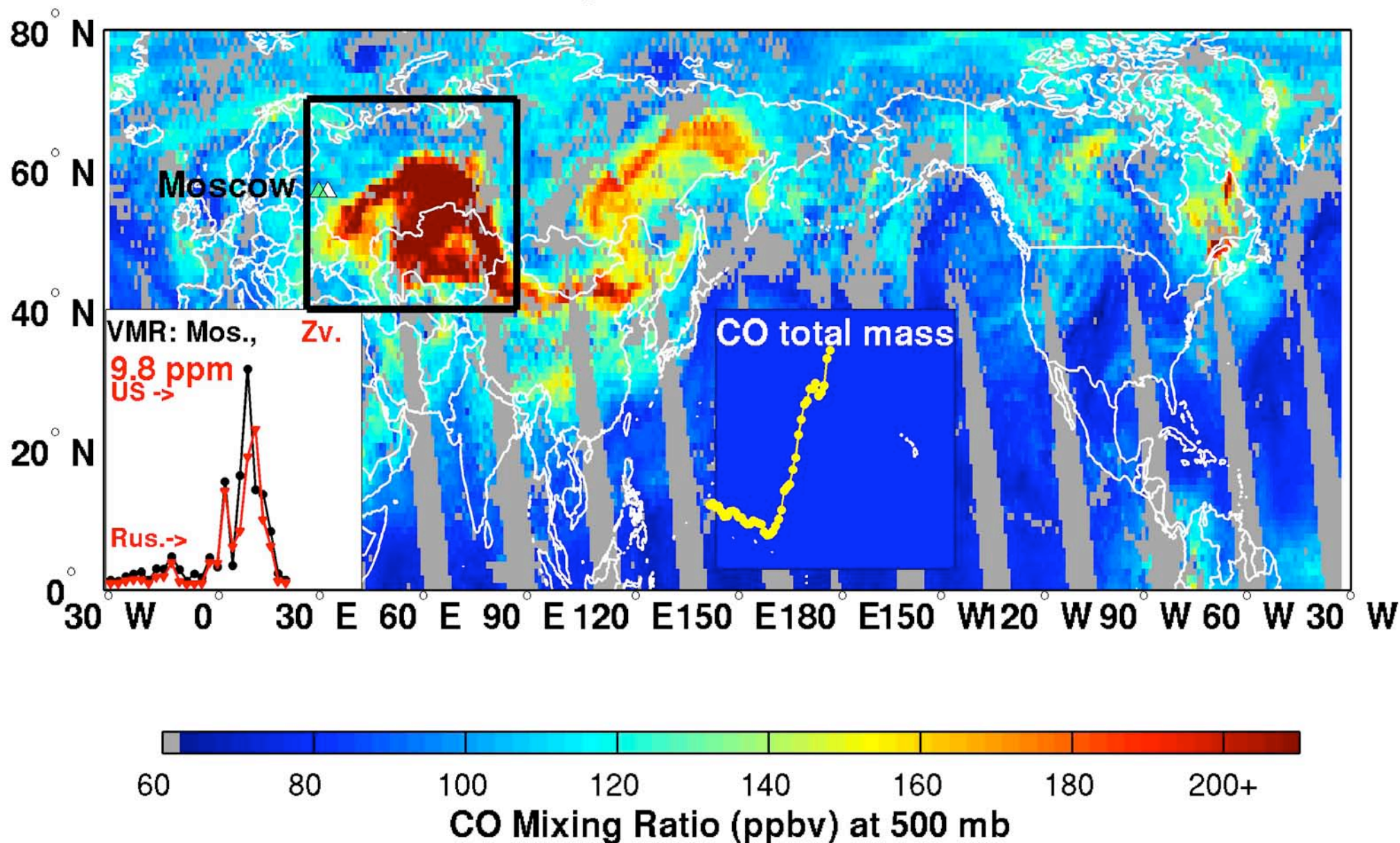
Local noon (ascending) AIRS CO at 500 mb on 2010.08.10.



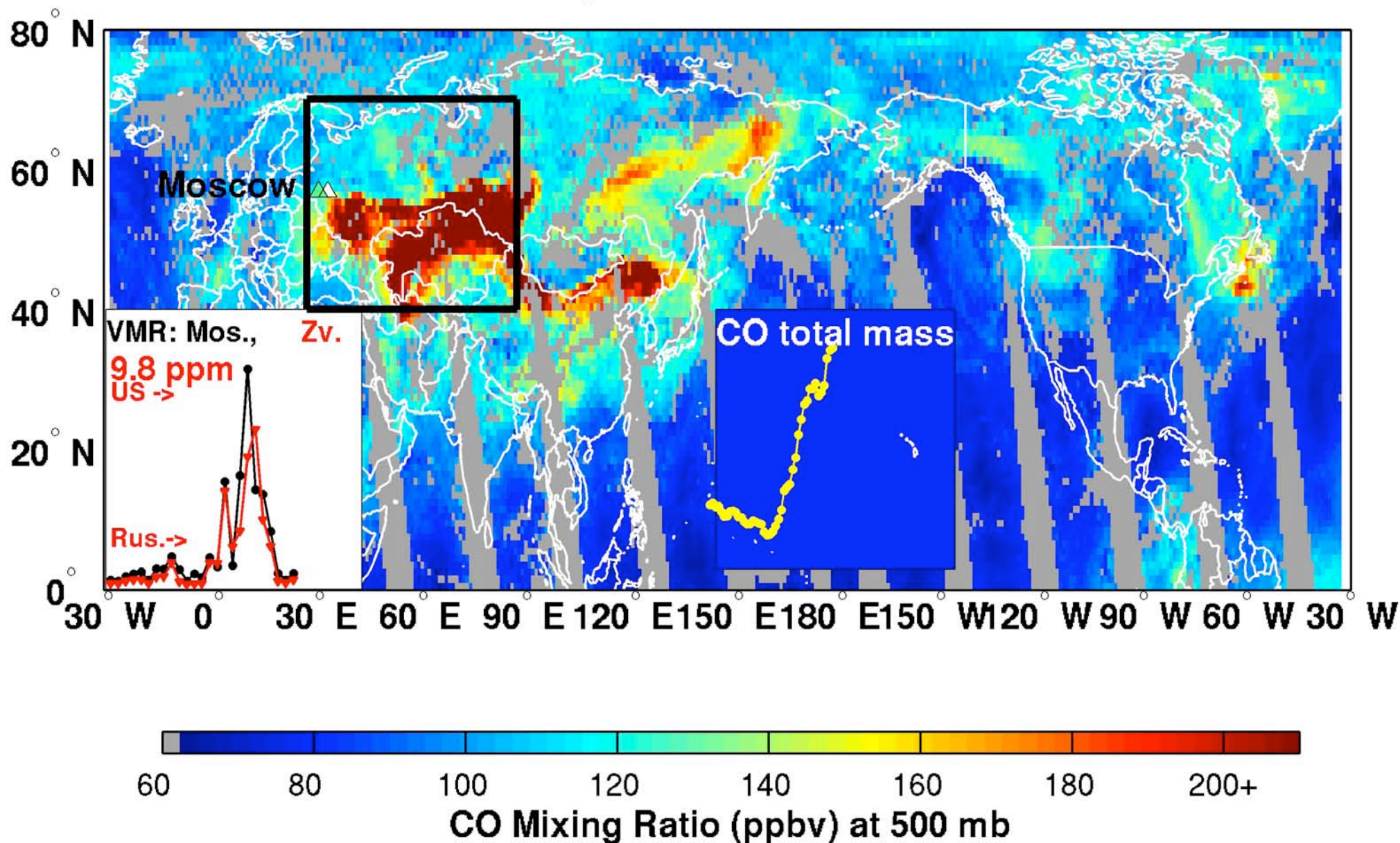
Local noon (ascending) AIRS CO at 500 mb on 2010.08.11.



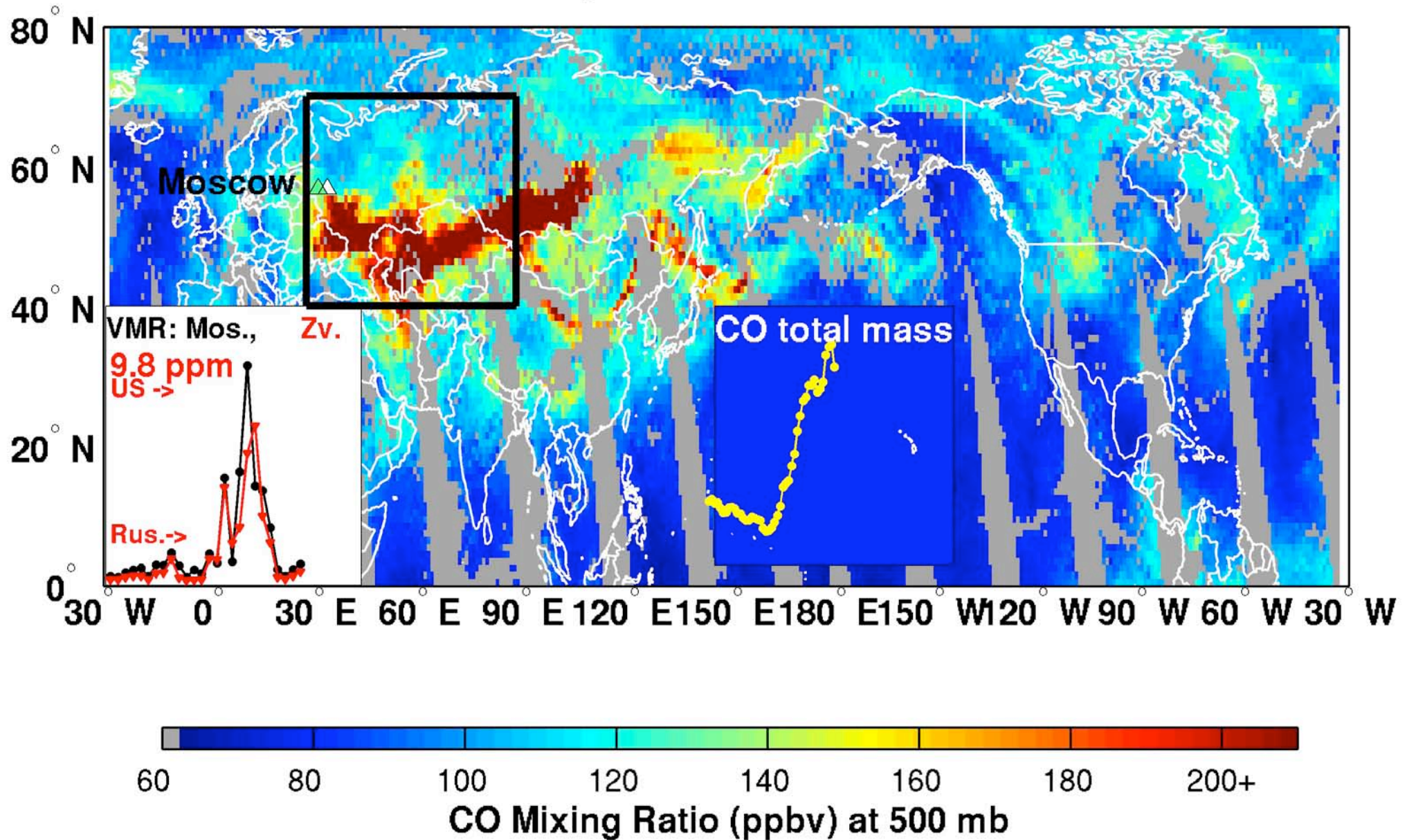
Local noon (ascending) AIRS CO at 500 mb on 2010.08.12.



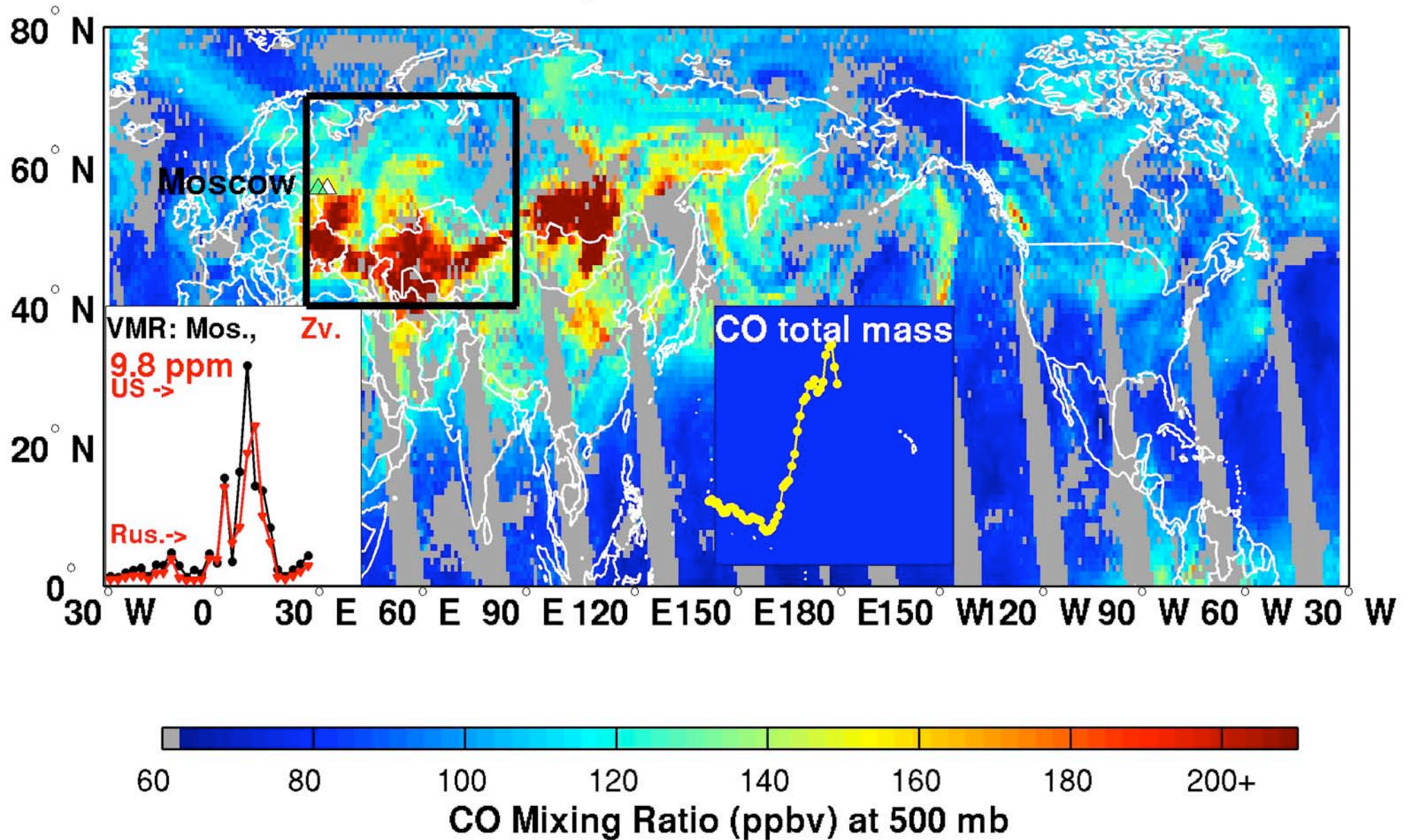
Local noon (ascending) AIRS CO at 500 mb on 2010.08.13.



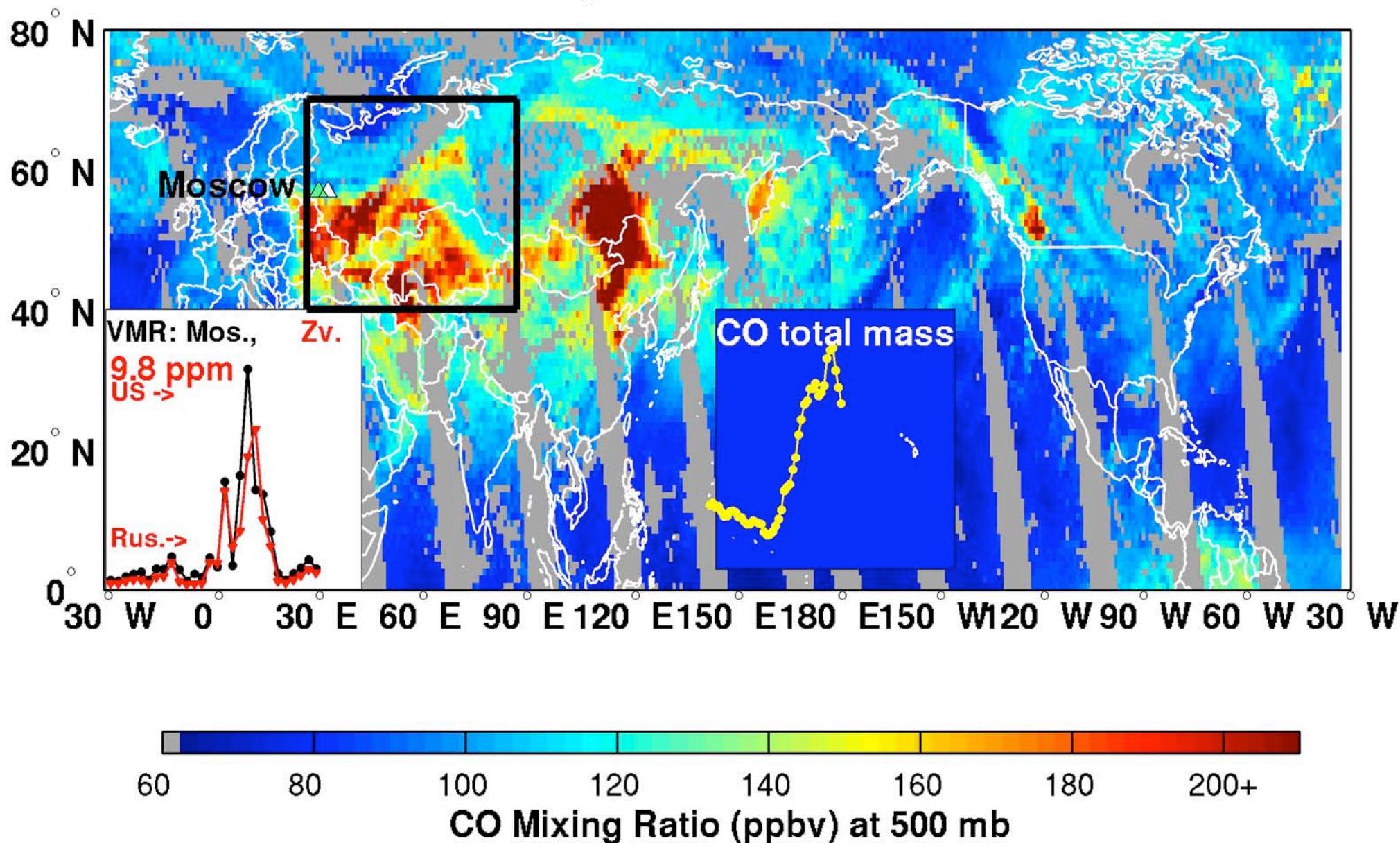
Local noon (ascending) AIRS CO at 500 mb on 2010.08.14.



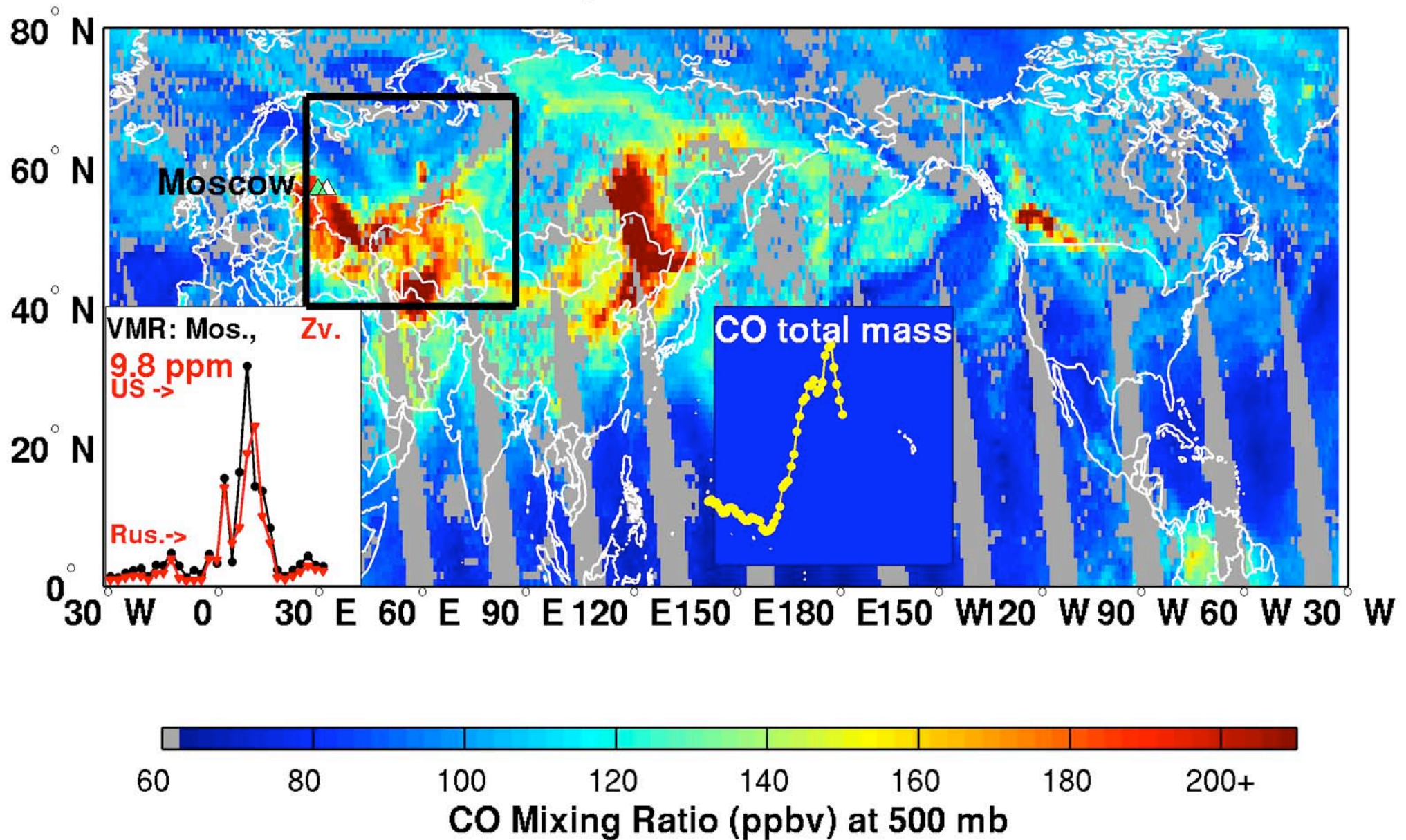
Local noon (ascending) AIRS CO at 500 mb on 2010.08.15.



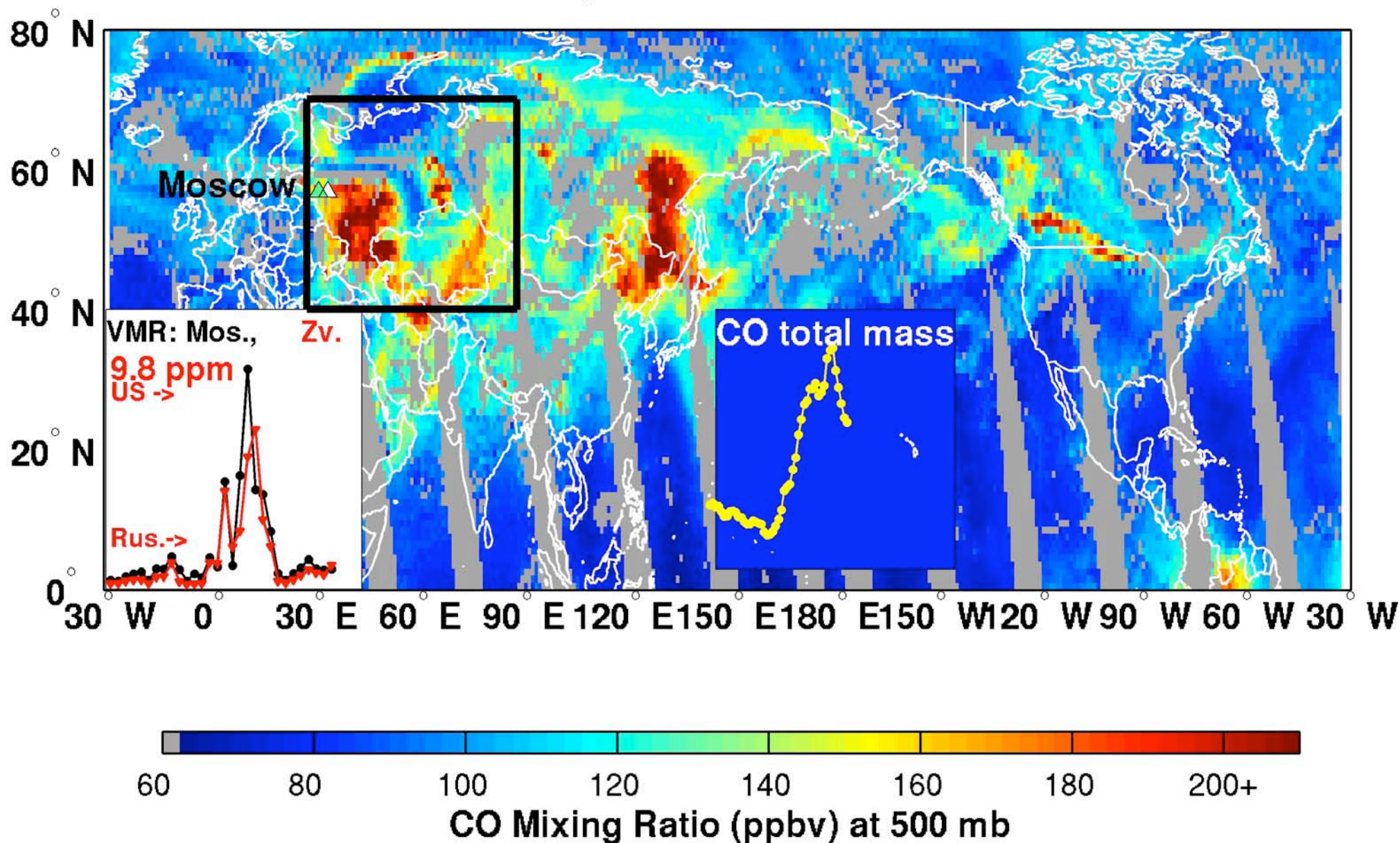
Local noon (ascending) AIRS CO at 500 mb on 2010.08.16.



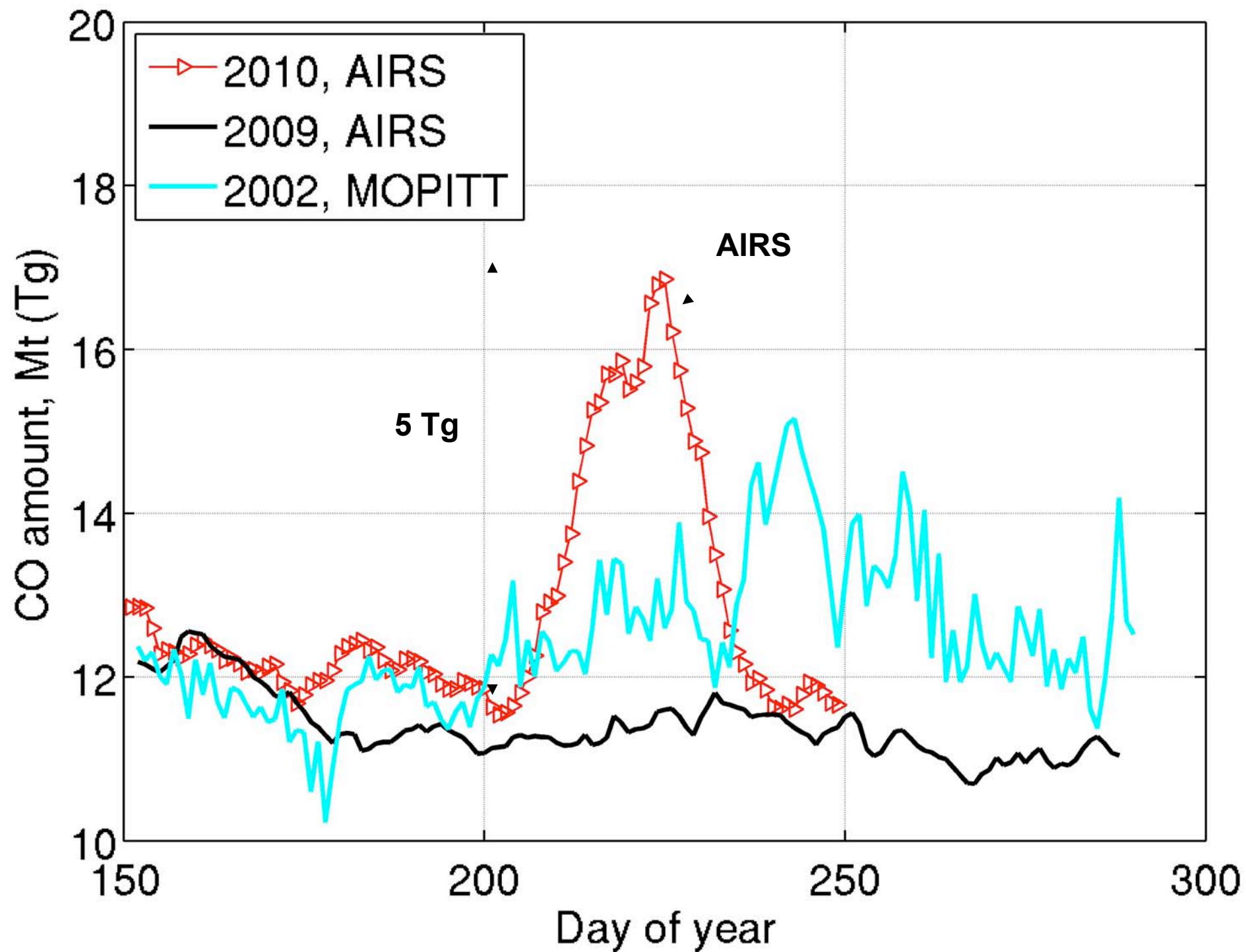
Local noon (ascending) AIRS CO at 500 mb on 2010.08.17.



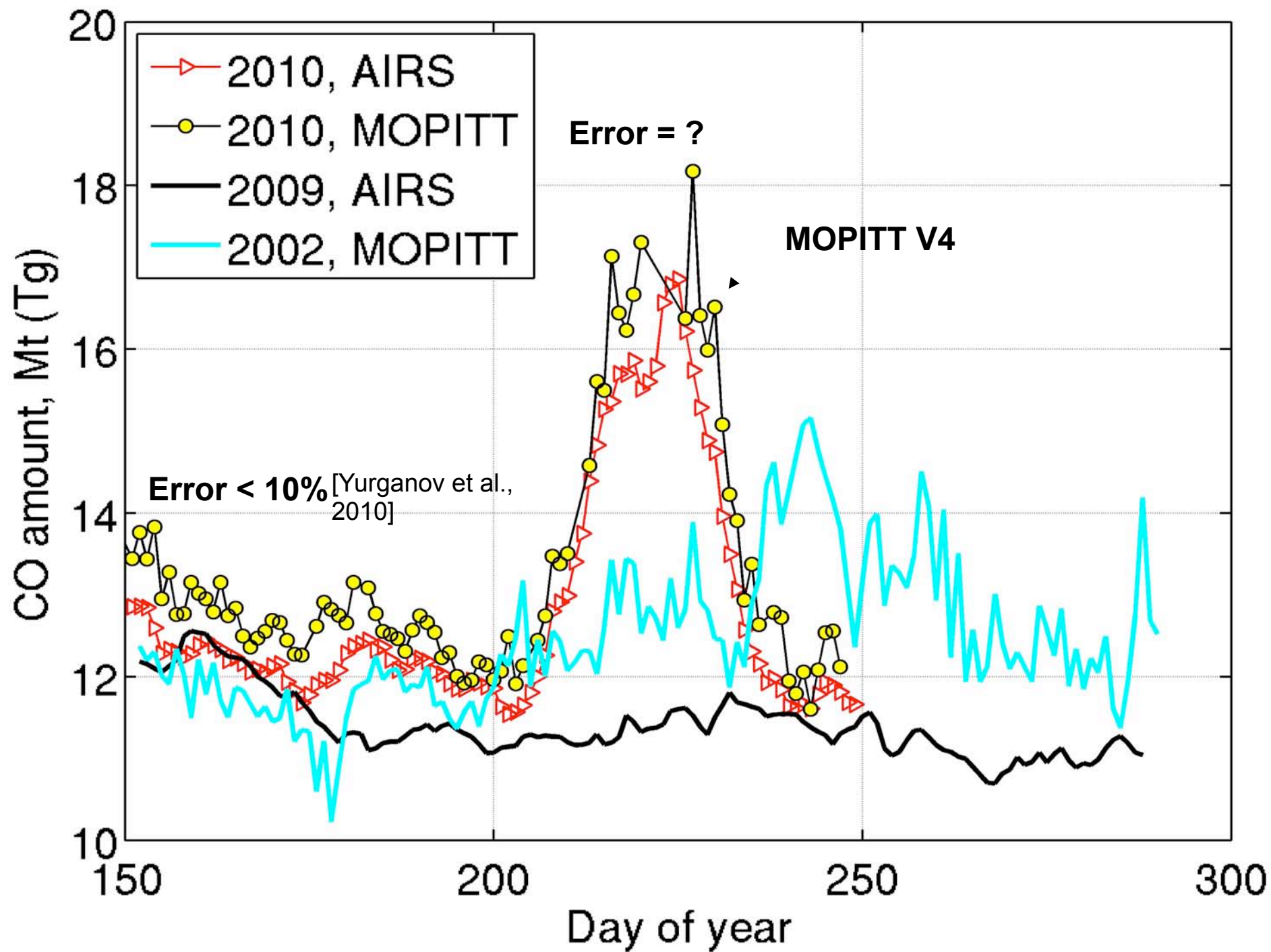
Local noon (ascending) AIRS CO at 500 mb on 2010.08.18.



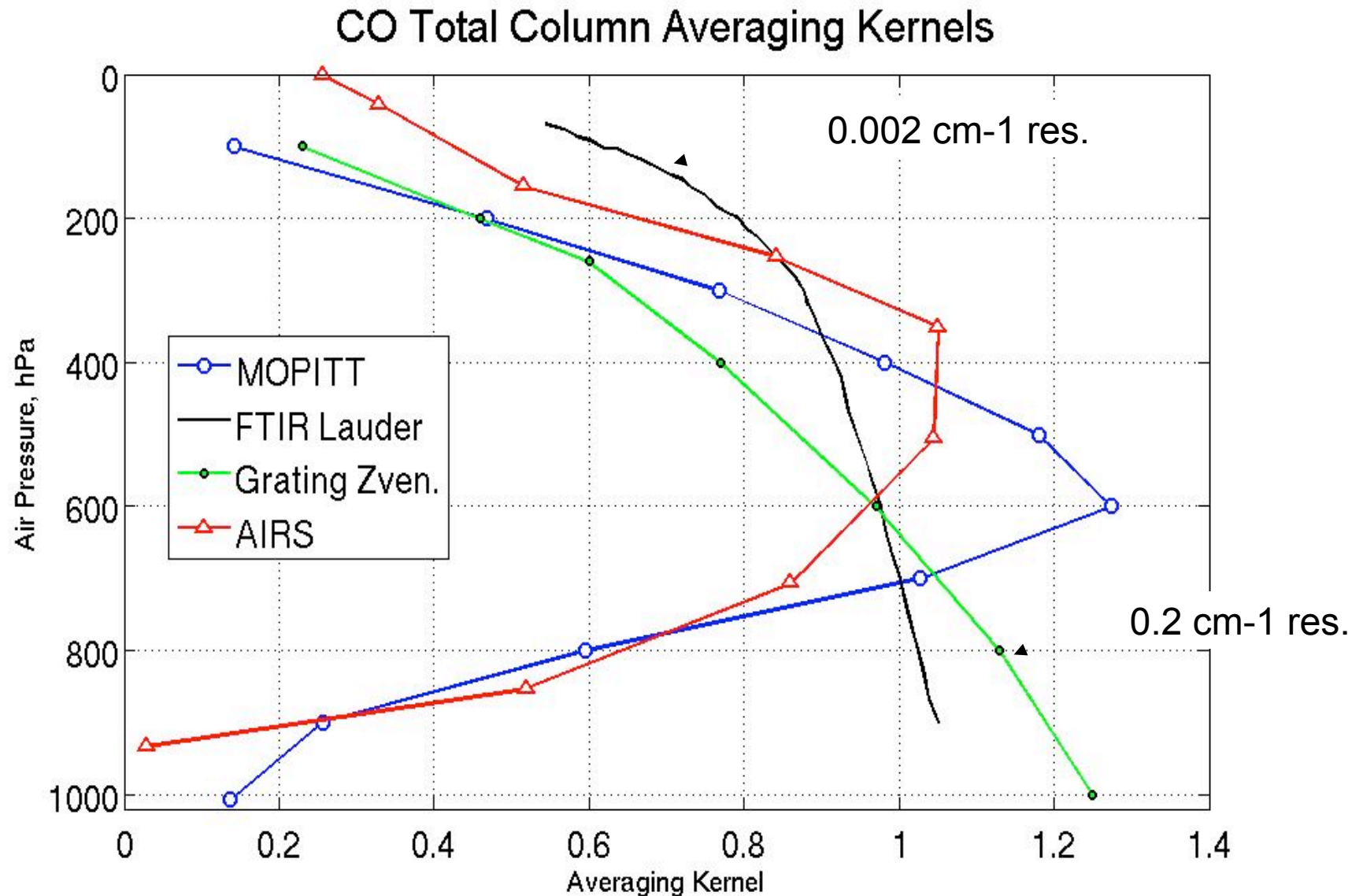
Total amount of CO over Central Russia



Total amount of CO over Central Russia

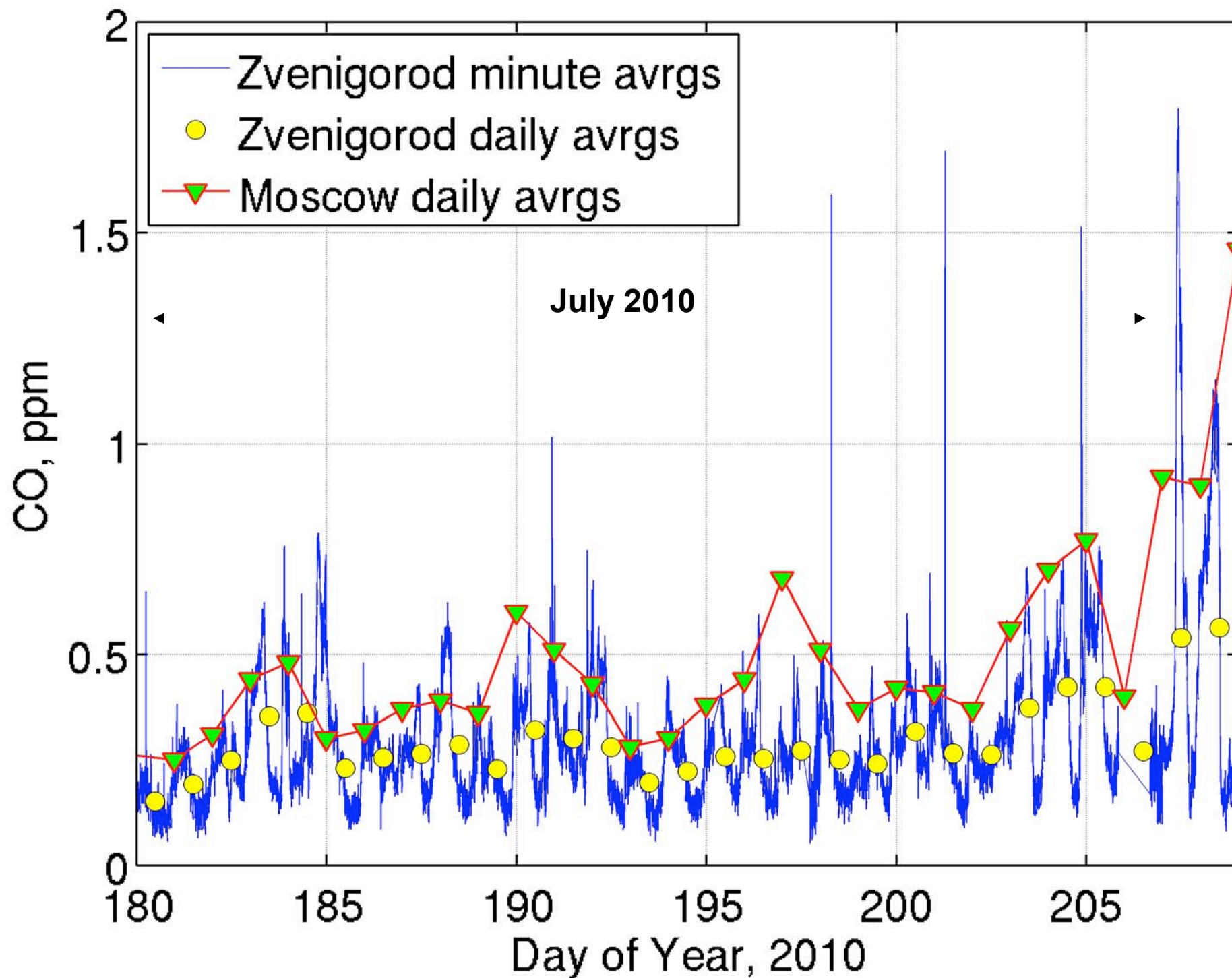


$$\text{CO}(\text{retrieved}) = \text{CO (a-priori)} + \text{AK} * (\text{CO (true)} - \text{CO(a-priori)})$$

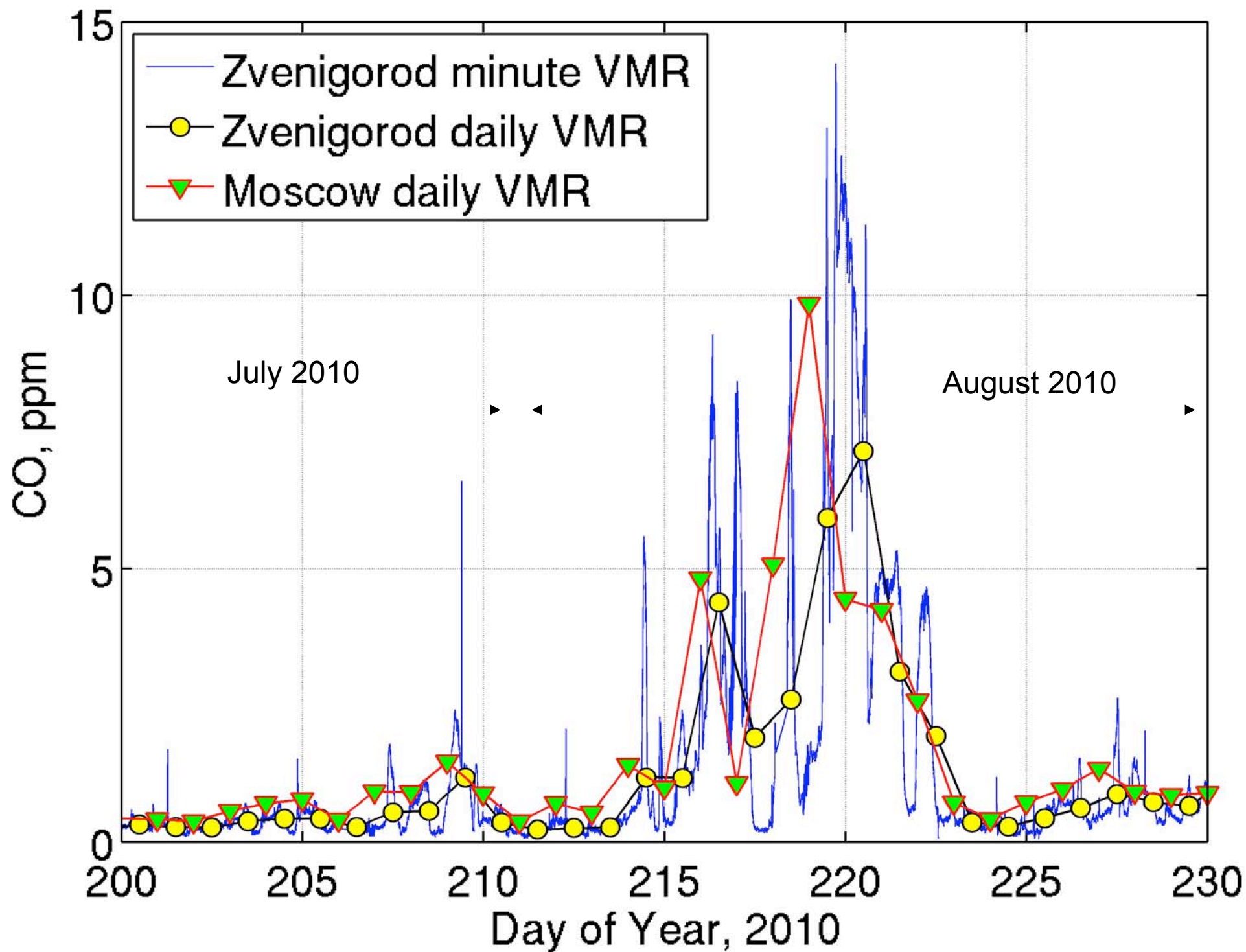


AKs: Lauder [Rinsland et al., 2002]; Zvenigorod [Yurganov et al., 2002]

Zvenigorod and Moscow CO surface VMR before fires

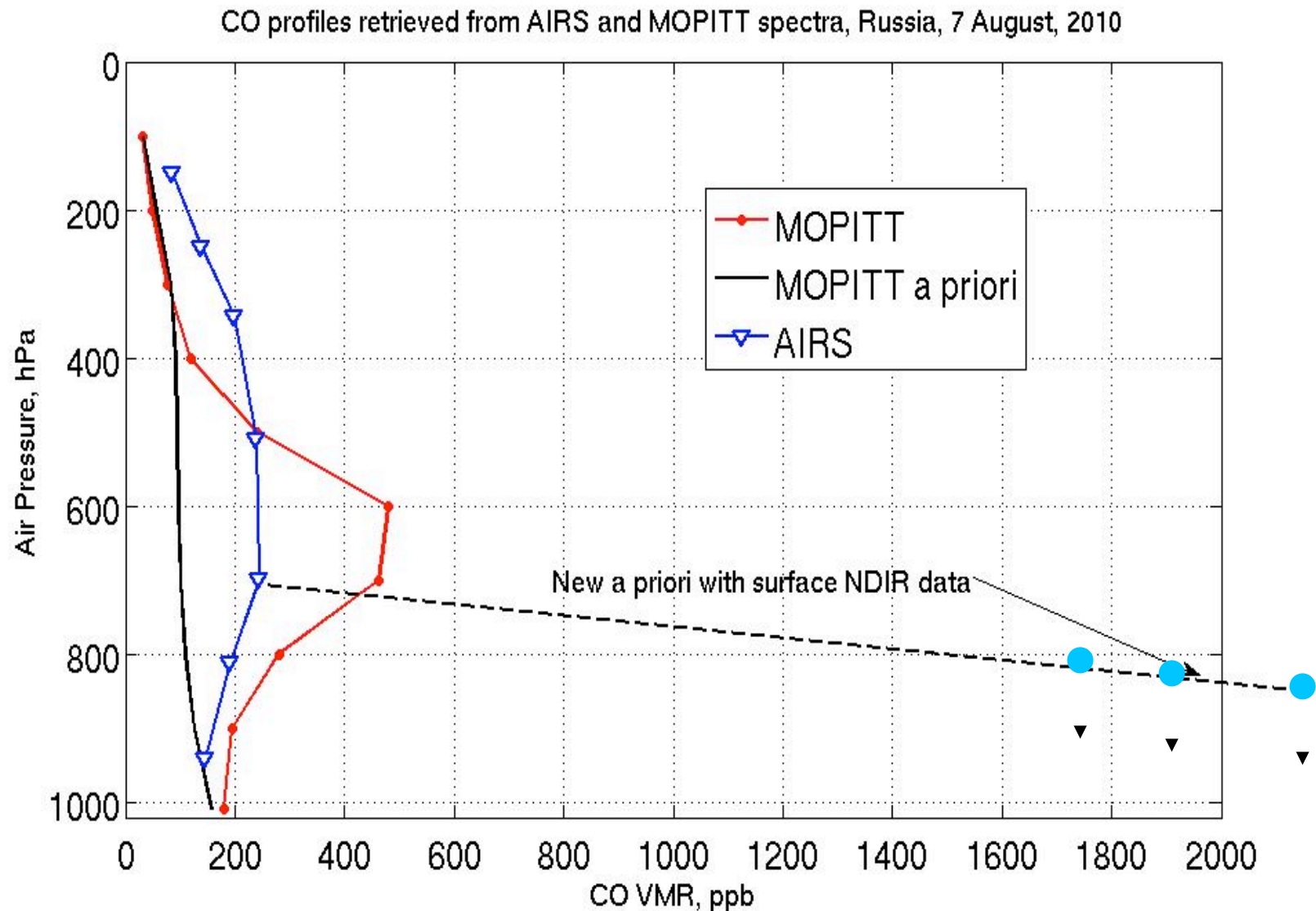


Zvenigorod and Moscow CO during fires

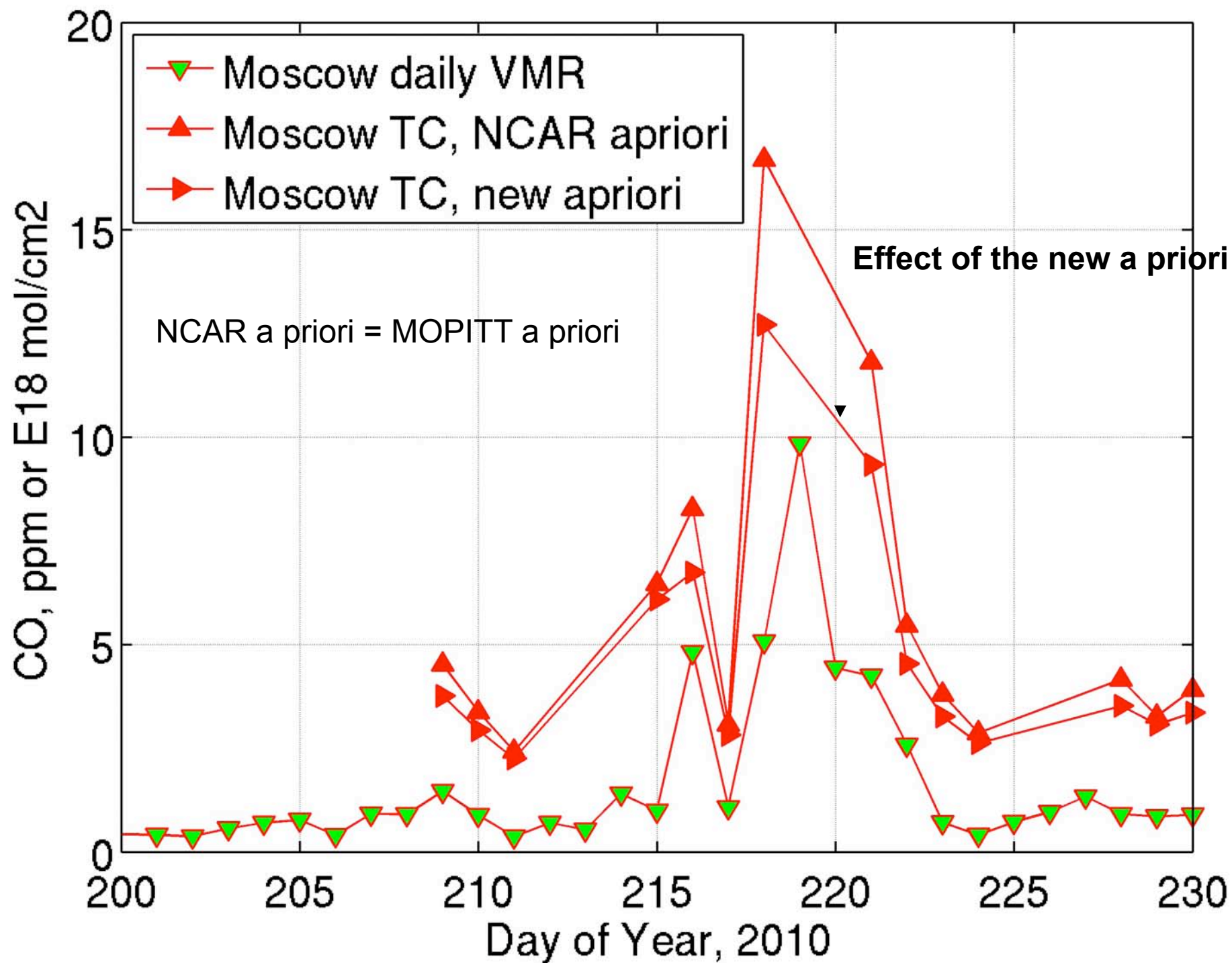


CO profiles, AIRS and MOPITT, standard retrievals.

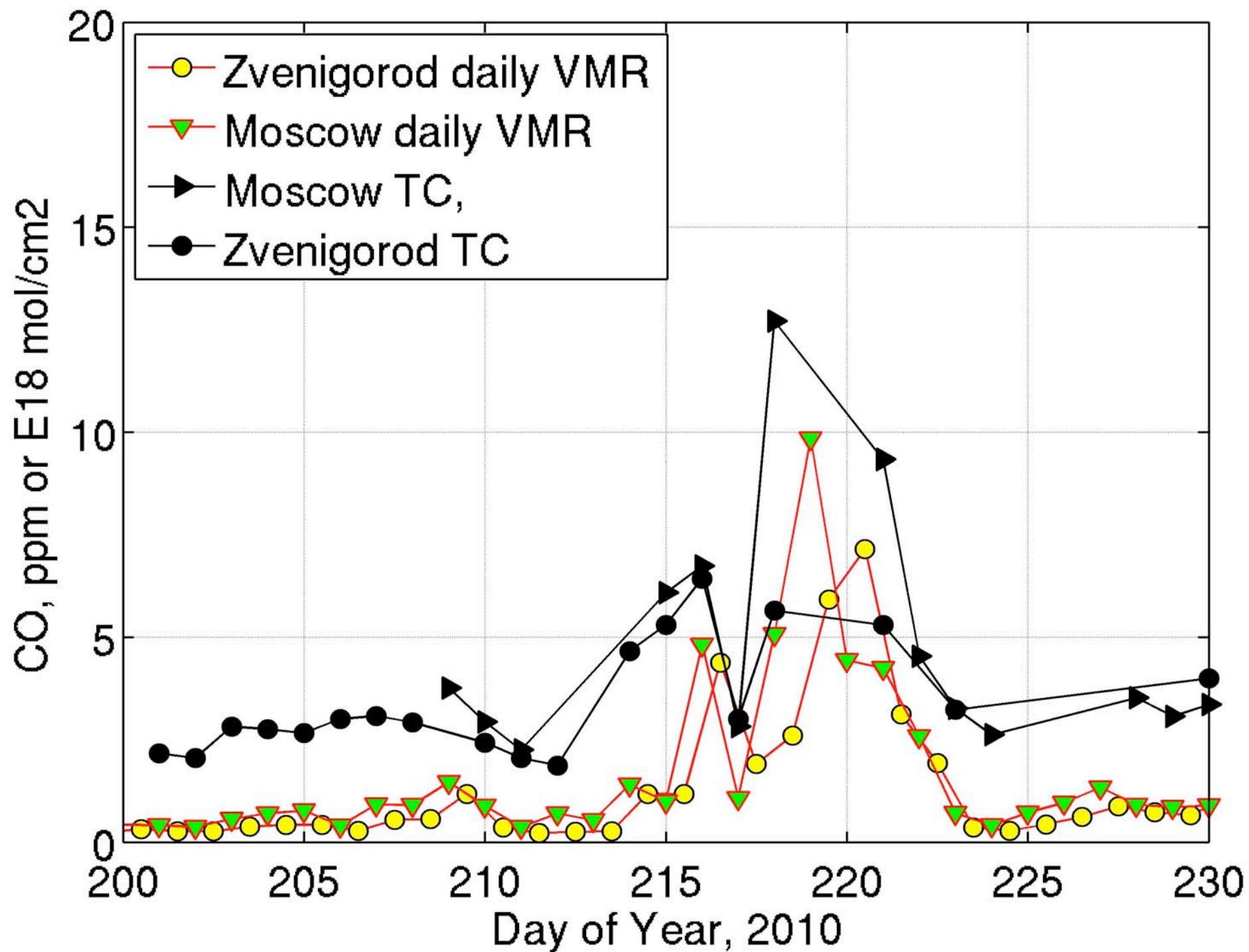
New a priori have the surface value from NDIR for each day and is used for reprocessing spectra of the ground-based spectrometers only



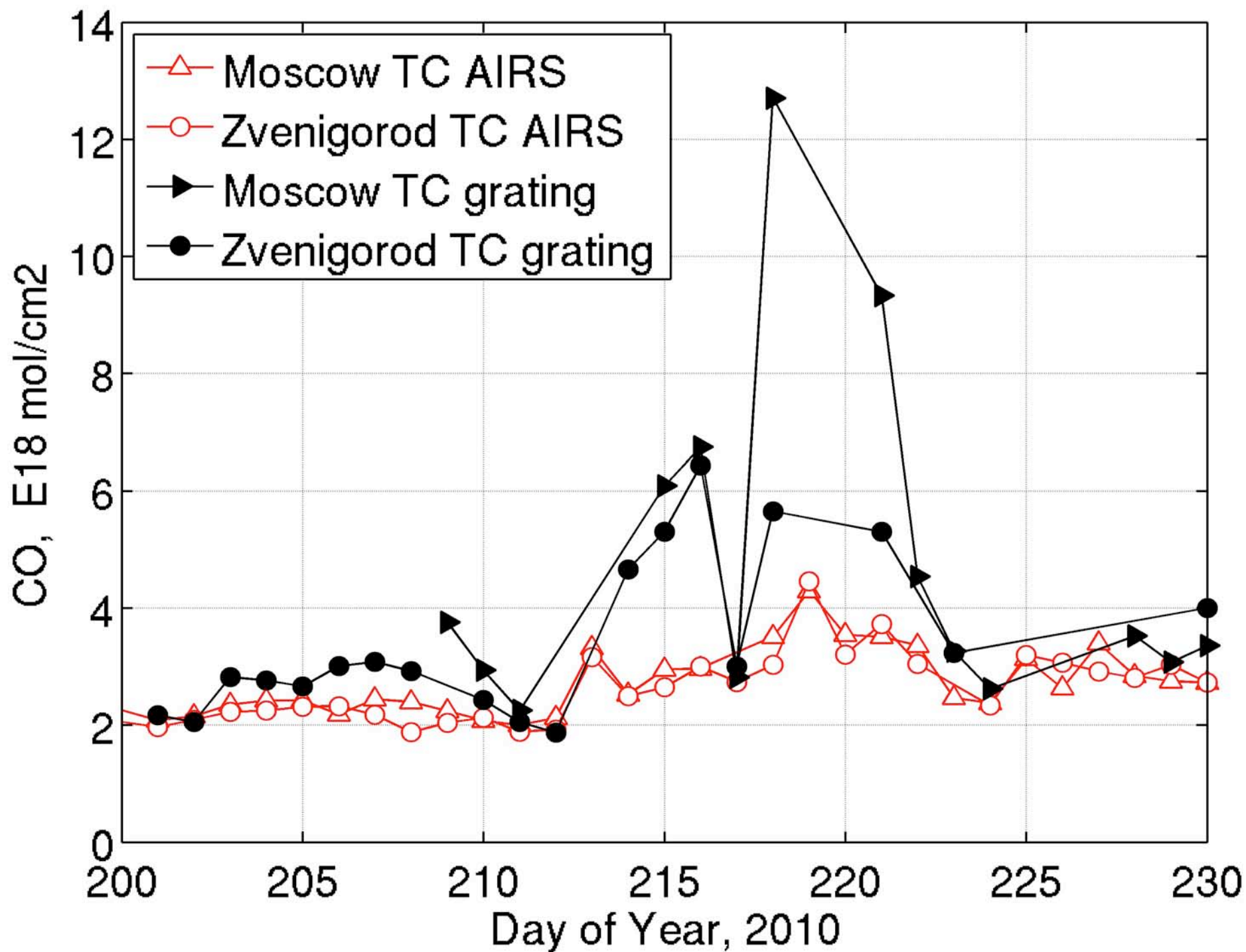
Moscow CO during fires



Zvenigorod and Moscow CO during fires



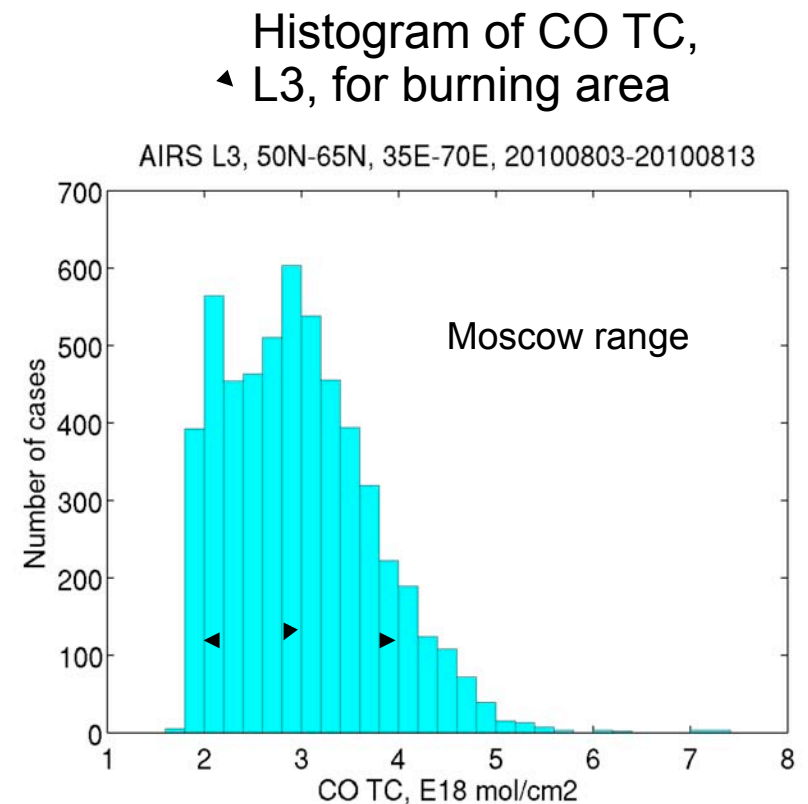
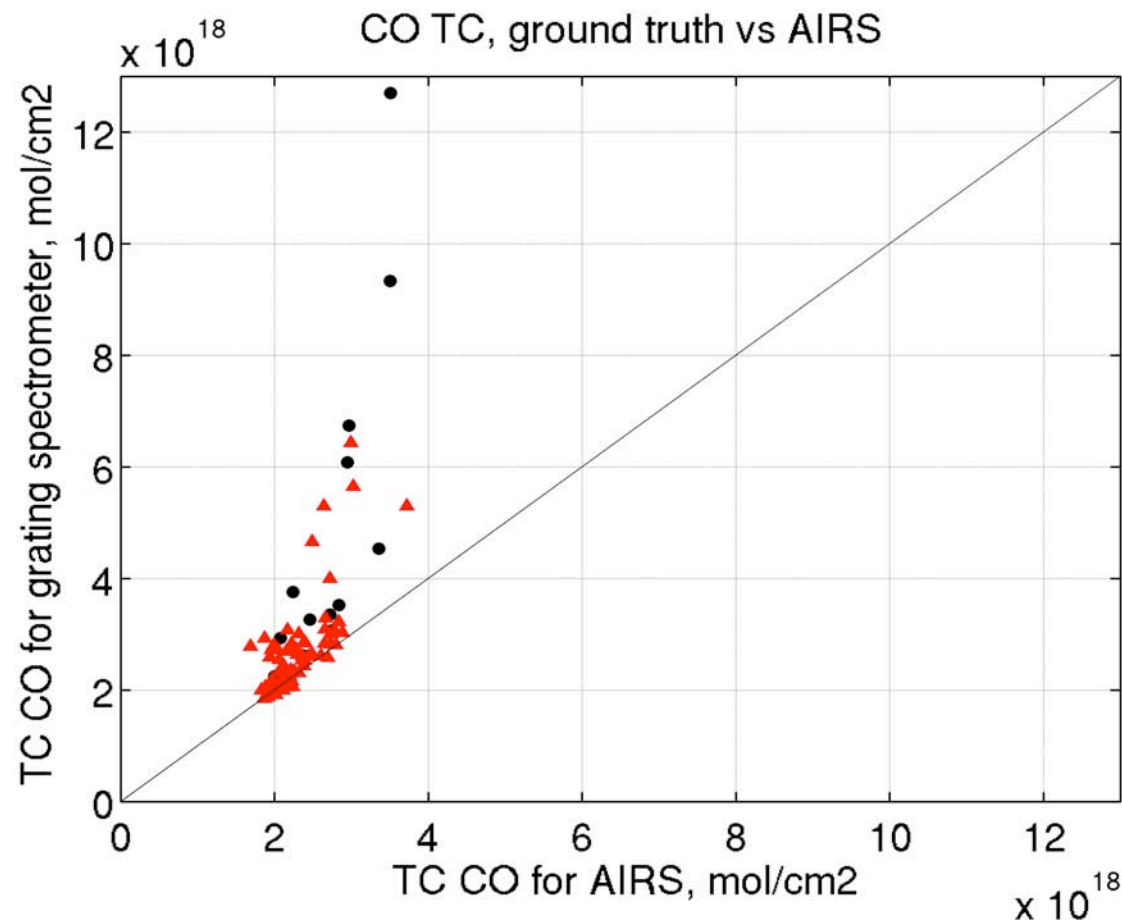
TC from the ground and from AIRS



1) Real CO total columns over Moscow area are a factor of 2 or 3 higher than that retrieved from the AIRS spectra. That is due to missing information from the BL.

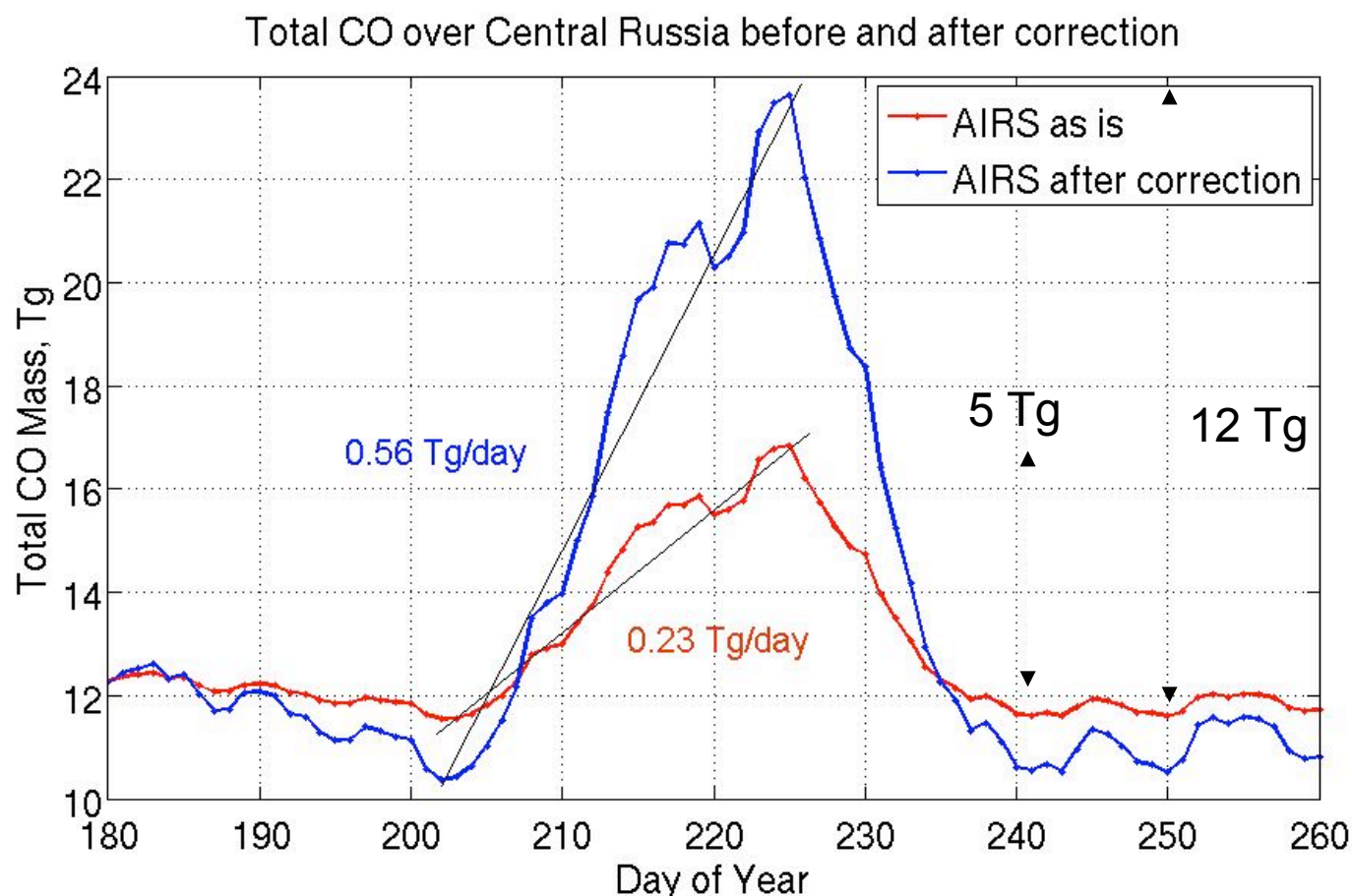
2) What would be the effect of this underestimation for the entire burning area?

Moscow (black), Zvenigorod (red)
(adjacent grid cells for L3)



Results of integration of corrected AIRS v5 L3 TC for Russia.

Total daily emission from fires is equal to increase of CO burden per day **plus** CO removed by wind and **plus** CO removed by OH per day.



Conclusions

- Retrievals for ground-based spectrometers just slightly depend on a priori and demonstrate 2-3 times higher CO total columns than AIRS and MOPITT.
- This validation effort will be used for an estimate of CO total emission from Russian fires.

Acknowledgements.

We appreciate collaboration with Larrabee Strow, Juing Warner, Zigang Wei (UMBC), Nikolay Elansky (Institute of Atmospheric Physics, Moscow), Igor Belikov (Moscow State University).



$\times 10^{18}$ CO TC vs CO surface VMR, August, 2010

